THE

ELECTRICAL REVIEW.

VOL. XXXVII. AUGUST 9, 1895. No. 924.

CONTENTS:

	PAGE
Signalling Through Submarine Cables	153
Electric Traction on the Conduit System	154
Uses of Accumulators	155
The Invention of the Electro-magnet	155
On the Effect of a Perforated Septum of Insulating Material in the Electrolytic Path of a Voltaic Circuit	157
Australian Electrical News	157
New Forms of Friction Brakes (*illustrated*) (*concluded*)	159
The Correct Diameter of a Brake Pulley (*illustrated*)	159
The North-Western Hospital Electric Lighting Tenders ..	160
On a Low Resistance "Dry" Accumulator	161
The Effects of Electric Currents in Iron on its Magnetisation (*illustrated*)	162
Payment on a Piece Rate System	164
The Civil Engineer	165
The Magnetic Qualities of Forged Steel (*illustrated*)	166
The Niclausse Water-tube boiler	167
Correspondence:—Secondary Batteries	168
Lighting the Thames Embankment	168
Legal	168
Business Notices, &c.	169
Electric Lighting Notes	170
Electric Traction and Motive Power Notes	170
Telegraph and Telephone Notes	171
Contracts Open and Closed	171
Notes	172
City Notes	175
Traffic Receipts	176
Share List of Electrical Companies	177
Location of Grounds in Armatures, Fields, &c....	178
Interview with Dr. Cornelius Herz	180
The Gas Light Company and the Electric Light	180
On the Use of the Quadrant Electrometer as a Differential Instrument	181
Alternate Current Motors (*illustrated*) (*continued*)	181
New Patents	183
Abstracts of Published Specifications	184

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 4/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1895 ISSUE READY.

PRICE 4/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.
Published every FRIDAY, Price 4d.
The Oldest Weekly Electrical Paper. Established 1872.
TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "ARKREAY, LONDON." Code A B C. Telephone No. 517.
ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.
The "Electrical Review" is the recognised medium of the Electrical Trades

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other Countries*, per Year, £1 4s.
BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.
CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.
FOREIGN AGENTS.—*New York*: D. VAN NOSTRAND, 23, Murray Street. *Paris*: VEUVE J. BOYVEAU, 23, Rue de la Banque. *Berlin*: ASHER & Co., 5, Unter den Linden.
Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 23, Paternoster Row, E.C.

SIGNALLING THROUGH SUBMARINE CABLES.

THE *Pall Mall Gazette* of August 1st publishes an interview with Dr. Herz on his system of transmitting 100,000 words per minute through submarine cables. It is a matter of extreme regret that a journal of the standing of our contemporary, when we consider the good work it has performed in the past in helping to expose one of the worst impositions of this or any other age, should put before the public such utter twaddle and inconceivable rubbish without apparently having taken the trouble to have any of the statements verified. It is also a matter of considerable surprise to us, assuming that the *Pall Mall Gazette* had not on its staff a representative with even the slightest knowledge of the working of submarine cables or overhead lines, why the editor did not engage a technical man *pro tem*; if such had been the case its readers might have been spared an article so misleading and so contradictory. Possibly, however, the real gist of the article may be discerned in the "personal views" paragraphs. In order that our readers may have a full account of Dr. Herz's epoch-making invention, we have, with the permission of our contemporary, reproduced the interview in its entirety in another part of this issue.

Dr. Herz's first statement is, to begin with, incorrect, for we know that instead of 20 words only per minute being capable of transmission over long cables, at least 50 words are obtained over one of the Atlantic cables of some 1,850 nautical miles in length. Moreover, the best telegraph instruments now transmit something between 450 and 600 words per minute over land lines connecting London with Dublin; in submarine telegraphy it is the cable and not the apparatus which limits the speed of transmission to so few words a minute.

To transmit 100,000 words per minute would require 1,500,000 electrical impulses, assuming five letters for an average word, and three impulses per letter. Now, supposing this is possible, how does Dr. Herz propose having the words committed to paper? A rapid penman cannot write more than 50 words per minute, and, at this rate, it would occupy him 33 hours to transcribe 100,000 words.

Dr. Herz says his system is applicable to all telegraph instruments in existence. We will consider two of them only—the siphon recorder and the sounder. Signals on the former are indicated on a narrow slip of paper, which is moved by clockwork. Each word would occupy at least 1 inch of paper, and 100,000 words would, therefore, require the tape to travel at the rate of 1·6 miles per minute. This is the lowest speed, as we have not allowed for spacing between words.

The signals on the latter instrument, as its name indicates, are read by sound, therefore the operator would have to mentally read and *write* down 100,000 words per minute. From these simple calculations, we think Dr. Herz's mathematical know-

ledge must be on a par with his electrical learning. Dr. Herz's experiments, if he has ever carried them out, appear to have been made on French telegraph lines, and not on submarine cables, a vastly different thing; his results whatever they were must therefore be utterly fallacious with respect to cable working. It is a wonderful thing that his visionary idea should be a secret, seeing that 61 electricians were employed on his experiments, and not one has yet divulged or turned the scheme to account; and here we would suggest that the doctor contradicts himself by stating later that he had described the invention to no one. This seems to reflect upon the intelligence of the three score and one French electricians who experimented for him, if not a single individual could grasp the essential feature of the idea which was then filling the doctor's wonderful brain, and which is ready to-day, it is claimed, for immediate application. Why did not Dr. Herz patent it?

It amuses us to hear of Dr. Herz posing as a great *savant*; we think there is not a person in the world who, knowing the man, ever looked upon him in that capacity. He is known to everyone for his doings in connection with the Panama Canal, but what has he ever done for science? Lord Kelvin, we imagine, would be the last man to consider him an authority on electrical matters, and we say this advisedly, our experience of Dr. Herz dating from the days of his attempted exploitation of poor Richard Werdermann's semi-incandescent lamps.

It is only charitable to assume that the peculiar nature of his illness has affected his brain, and the 100,000 words per minute through submarine cables is only one of the chimeras which a man in his state can so readily conjure up. We are glad to see that the *Contract Journal*, without entering into calculations, administers a smart and well deserved rebuke to the *Pall Mall Gazette*.

ELECTRIC TRACTION ON THE CONDUIT SYSTEM.

The utilisation of conductors contained in a sub-surface conduit for electric traction in cities has again been brought prominently to the fore by the experimental lines lately constructed in New York and Washington, and which have been described fully in the technical press of America and Europe during the last few weeks. We cannot see that any great improvement over constructions heretofore proposed are embodied in the New York installation, which is naturally the more prominent of the two, and which, we understand, has the approval of the General Electric Company of America.

There are undoubtedly points in which the structure has been mechanically improved since the old Bentley-Knight system was used in America between 1884 and 1889, as well as upon that now in operation in Buda-Pesth; but the one difficulty of greatest importance, that of cost, would seem rather to have been increased than diminished.

We have never doubted that an electric conduit could be practically worked, provided that the expense of its installation was considered a secondary matter. The New York conduit is if anything somewhat deeper than the ordinary cable conduit, and undoubtedly embodies the latest results obtained from practice in cable tramway construction. It has consequently approximately the same costs of construction to meet as well as the objections to be urged against such an extensive reconstruction of the roadway as is thereby entailed. The slot is still an objectionable feature, and the amount of iron required upon the street surface presents the same disadvantages in the way of interference with vehicular traffic.

We note also that it has apparently been found impracticable to use a higher pressure than 300 volts instead of the 500 volt current universally employed with elevated conductors. This very much increases the cost of feeders, and even in the trolley system this cost is very heavy where the best service is required.

Altogether, we cannot see that any great step forward has been made, and we are of the opinion that the trolley system is not likely to be extensively affected until some more radical improvement has been made than is shown by the New York installation.

Where a conduit of such high cost can be supported, it is difficult to see where electric traction can have a greater value than the cable. Moreover, we are strongly of the opinion that a properly constructed overhead line of conductors with ornamental poles and taut wires, is less disadvantageous even in city service than a system which involves the tearing up of a large part of the street surface during construction, with the attendant probability of extensive interference with gas, water, sewage, electric light, &c. The overhead line possesses the great advantage of enabling a mechanically propelled traction system to be installed with comparatively little interference with the roadway, and it remains always independent of the roadway, so far as operation, repairs, or reconstruction are concerned. It has also the advantage that its cost is within reach of any tramway operated by animal power upon a fairly large scale, and it has demonstrated its ability to effect a substantial reduction in the operating expenses of such tramways, while at the same time greatly adding to the public convenience. The conduit system has one advantage only in its favour, namely, that it dispenses with the use of elevated wires, and it would seem to us that the price paid for that problematical advantage is, so far, much too high.

In the lines now being constructed in England, and upon which the verdict of the public and the engineering profession must be based, the constructors have adopted the wise policy of utilising the very best apparatus throughout, and we believe that the success attached to their working will be sufficiently great to very considerably extend the introduction of electric motive power. Up to date the trolley has certainly little to dread from the conduit.

Submarine Telegraphy and its Development.

In the *Annales Télégraphiques*, 3e Série, Tome xxii., there appears a very excellent article by Mons. E. Morris which should be read by those interested in submarine telegraphy and its development. Mons. Morris shows an intimate knowledge of his subject, and the article is interesting from an historical and from a technical point of view, and has the great merit of being concise. The establishment of a submarine cable works at La Seyne, near Toulon, presented serious difficulties on account of the locality in which it was thought advisable to erect them. The shallow water approach and the marshy ground in which the foundations of the buildings and machines lie, caused considerable trouble, which has been successfully overcome by Mons. Morris, his assistants, and their predecessors. Mons. Morris gives credit to Mons. Ailhaud and Mons. Amiot for their part of the work in forwarding the scheme of a State-owned telegraph cable factory, and also makes a graceful allusion to Mons. Cochery, ex-Minister of Postes and Telegraphes, and to Mons. de Selves, the present Director-General. This recognition of the services of others is none too frequent among technical men in France and elsewhere, and Mons. Morris's modesty is the truest sign of his own knowledge and power.

USES OF ACCUMULATORS.*

By J. S. WEBSTER.

Mr. Howell's paper with the above title, printed in the London Electrical Review of May 24th and 31st, and noted in the "Digest" of June 15th, is a timely and valuable contribution to electrical literature, and is worthy of careful study by all who are interested in the general improvement of electrical service. While the object of this paper is to demonstrate the adaptability of accumulators to large central stations, the data given can be practically applied to a wide range of circumstances. For instance, the statement is made that an accumulator added to a residence plant operated by gas or gasoline engine, has in some instances effected a saving of over 50 per cent. in fuel and furnished continual service as compared with a 10-hour service from engine. This is easily comprehended when we consider that the ordinary plant is seldom operated at more than a fourth to half its capacity, and that when the load factor is so small the fuel consumed per unit of output is nearly three times as great as when operating at highest efficiency. When a plant is operated at a fifth of its capacity, about the same amount of fuel is required to overcome mechanical friction as is utilised to supply the current. We do not forget that our storage system also operates at lower efficiency with very light load, but the energy necessary to overcome resistance is small when compared with that necessary to overcome friction.

Economy can hardly be considered the main object of the accumulator in residence lighting, as those who are able to purchase their own plants will not be likely to consider the slight operating expense of same. This, of course, does not apply to plants propelled by steam. A steady light, and an always available service, are the recommending features of the accumulator, and when we couple these with economy of operation, it is not easy to comprehend how any person wanting first-class service can hesitate to avail himself of these features when the small outlay is not prohibitory, and when the accumulators will be installed by firms of the highest responsibility under a guarantee of low cost of maintenance for a term of years.

The data submitted by Mr. Howell will be amplified when applied to electrical railway practice, where the fluctuations of load are so sudden and of such short duration that not only does the mechanical system operate with low fuel economy, but the excessive strain renders it necessary to equip the station with apparatus of abnormal strength and capacity. The mechanical plant is not capable of maintaining a constant potential, which results in fluctuating lights (in evening) and low economy of motor service. The success of recent application of accumulators to railway service demonstrates that the above obstacles are quite satisfactorily overcome by their adoption.

Machinery of special design becomes unnecessary when coupled with accumulators, and if all these points are given due consideration beforehand, the equipment of an economical station, embodying the most desirable features, does not require so much outlay as is often expended upon stations that have failed to pay dividends.

When we consider that in central stations, and even in railway practice, a fourth of the plant is simply used as a reserve, and only renders service a few hours a day—sometimes being idle for weeks—we are not surprised to find no dividend at the end of the year. This might, upon first thought, seem to apply equally to accumulators, but it does not. Accumulators work at high economy on comparatively low rates of discharge, and are able to handle excessive loads for short periods in a creditable manner. The engines of large units are operated at their highest efficiency about three-fourths of the day, and all extremes taken care of by the accumulators.

* *Electrical World*, New York.

THE INVENTION OF THE ELECTRO-MAGNET.

In an article which appeared recently under the above heading,* M. Pellissier has thought it his duty to correct an alleged *error* of Prof. S. P. Thompson's in his remarkable work on "The Electro-magnet and Electro-mechanics," and even to accuse him somewhat sharply of *perverting the truth*.

Speaking merely as translators of this work, and consequently as impartial participators in this controversy, we (says E. Boistel in *Revue d'Electricité*) should nevertheless not wish it to be thought that we had accepted unreservedly and allowed to pass without comment an error *also in opposition*, according to M. Pellissier, *to the irrefutable documents inscribed in the great volume of history*; we will therefore go rather more to the bottom of this affair, at the same time taking the ground that he has taken himself. Far from blaming his Chauvinism, which is not at all misplaced, we will ask him to allow that we are as mindful as he is of the glory of our great men, and as desirous of giving to everyone his due; but we will ask him to moderate his youthful ardour; "he who tries to prove too much proves nothing."

M. Pellissier, in order to justify the conviction in which he and many others have been brought up, calls to witness in the first place all the writers that have discussed this branch of electrical science. Without stopping to enumerate them, we grant that the discovery of the electro-magnet was, at any rate, formerly attributed to Arago. But we find to our great astonishment that the best works of recent date, in which we hoped to find some information, are absolutely silent on this point. Are we to understand from this that they concur in the general belief, or is their silence an act of prudence dictated by the great difficulty very often experienced in solving these questions of priority, and by the fear, no less well founded, of starting idle disputes of no scientific or practical value. We cannot tell, and therefore we merely chronicle the fact. As to what preceded these modern works, we can only say, with Montesquieu, that "there are things that everyone says because they have been once said."

We will therefore simply refer to the documents quoted by our opponent, which are at the same time the most authentic. These are the reports of the sittings of the Bureau des Longitudes (1820), the communications to the Académie des Sciences as reproduced by the *Moniteur* of the same year, the Annales de Chimie et de Physique, also for 1820, the whole of these being also reproduced in the *Oeuvres Complètes* of François Arago, published in 1854, where we find in Vol. iv., Scientific Notices II., under the title "Electro-Magnetism" (posthumous work), p. 405 and following, the complete history of the question, summed up in this principle, enunciated by Arago himself, p. 429:—"I maintain, as a general thesis, that a publication, through any channel whatever, is the only claim to consideration that can be admitted in the history of science."

No; if we read in these works that the voltaic battery *does magnetise soft iron*, we must see under what form and what conditions; the first communication to the Académie des Sciences tells us this:—"The straight connecting *wire* which establishes communication between the two poles of the Volta battery *becomes covered with iron dust*, as a magnet would. This wire, therefore, does not act solely on the needles already magnetised, but it also develops magnetism in the iron that has not previously been subjected to magnetisation. *Compass needles that have not previously been magnetised* are also deflected by the action of the connecting wire." As will be seen, we carry the quotation further than M. Pellissier. This is followed by the detailed description of the discovery which dwells continually on the *iron dust*, which at length gives the connecting wire the thickness of an ordinary quill. Arago certainly said:—"Œrsted had only found out the action exercised by the voltaic current on a needle previously magnetised. On repeating the experiments of 1819 of the Danish physicist, I found that this same current develops the magnetic influence in *plates of iron and steel*, which were before quite without it." But this

* See *l'Eclairage Electrique*, Vol. iii., June 8th, 1895, p. 472.

relates merely to the repetition of Œrsted's experiment on iron, and although the expression "plates of iron" is used, they are not mentioned in the experiments, the compass needles not previously magnetised being necessarily steel needles. Arago also found in this first experiment that the connecting *wire* only communicates to the soft iron a *momentary* magnetisation, which ceases with the current. But he only deals with *wire*, and only with *straight* wire; he tries, or endeavours to try, metal wires differing in mass, form, and diameter. "The copper connecting wire," he says, in conclusion, "is endowed, as we see, with a very strong magnetic influence as long as it is in communication with the two poles of the battery. It even happened more than once that I found in *it* traces of this property still remaining a few moments after the communication between the two poles had been completely interrupted; but this phenomenon is very fleeting."

In this memorable experiment, then, the illustrious academician only studied and recorded one single fact, the power of a *straight* metallic *wire*, traversed by a current, to magnetise steel and to magnetise momentarily particles or fragments of iron by attracting them, a property belonging to the wire and not to the iron. But let us go on from the same book. In the following chapter "Magnetisation of a needle by means of the passage of the electric current in the form of a helix," there is no longer any question of soft iron, but only of *steel* needles, of which, as Arago himself says, he had not arrived at ensuring the constant position of the poles, and which he had only with difficulty succeeded in magnetising.

Ampère had only then made his important discovery of the mutual and reciprocal action of two rectilinear wires traversed by currents, from which he had deduced by analogy his theory of the elementary constitution of magnets. It was when he was witnessing the experiments that Arago had come to show him that his genius suggested the sudden idea of winding the wire in a helix, and placing the *steel* needle in the centre. "He hoped thus to obtain a stronger magnetisation and a constant position of the poles, which was not arrived at by Arago's method." The experiment was made at this very meeting between the two *savants*, and is historical. And Arago admits that "after staying a few minutes in the helix, the *steel* needle had received a considerable amount of magnetism; the position of the north and south poles was moreover perfectly in accordance with the result that Ampère had deduced beforehand from the direction of the elements of the helix, and from the hypothesis that the electric current traverses the connecting wire going from the zinc end of the battery to the copper end."

The solenoid was then evolved, thanks to Ampère's genius. Arago renders him full justice by giving him the credit of the success of his experiment, and trying to explain the comparative failure of his first attempts.

From this point the two eminent scientists pass to the study of the action of two consecutive helices wound in opposite directions, and to the creation of the consequent poles in the *steel* needles. The magnetic action of the solenoid is perfectly defined, so well that Arago admits that in his first experiments he only gave poles to his sewing needle with the rectilinear wire by the fact that, in order to hold this needle better, he wound the wire a little around its extremities. Apart from this last fact, which is mentioned incidentally, we do not think that anything can be found in the above faithfully recorded quotations of a nature to establish on Arago's part the discovery, or the claim to the discovery, of the electro-magnet. He had only in view the magnetic properties acquired by a metallic wire traversed by a current, and manifesting itself by *the momentary attraction of iron dust*, and then the constant polarity imparted to *steel* needles subjected to the action of a *helical current, the idea of which was due to Ampére*, and nothing seems to us to justify this assertion of M. Pellissier that: "The electro-magnet was created by these researches, as far as its essential elements are concerned, viz., the temporary magnetisation of *soft iron* by a conducting wire wound in a helix several times *round iron, in order to increase the intensity of magnetisation*," any more than that "Sturgeon's experiments only differ from those of Arago in the fact that he employs a *thicker core*."

In the experiments of Ampère and Arago, there is no question of *core*, and on this point the whole question turns. They discovered, and defined clearly, the magnetic properties of the *solenoid*, which are found again in the electro-magnet, but they did not conceive the idea of *reinforcing* its external magnetic action *by the insertion of an iron core*, which is an essential characteristic of the electro-magnet. That they opened up the way, no one disputes; but they did not invent the electro-magnet. For them, iron remained a *passive* subject; it was only in a certain fashion, and, at the most, the armature of Ampére's solenoidal magnet, since *steel alone was subjected to a helical current*. These two great *savants* invented, if you will, the electro-magnet *with an air core*, but not the electro-magnet with an iron core as we know it at the present day.

The part that they really played in this discovery is sufficient for their renown, when we consider all that they did besides. The fame of Archimedes, Lavoisier, and Faraday is not tarnished by the numerous applications made of the lever since the days of antiquity, by the invention of smokeless powder, or by that of the Pixii, Pacinotti, and Gramme machines; but we cannot attribute to them the merit of these later inventions. The successive labours of the scientists of the whole world are every day leading, step by step, to new discoveries; but, whatever M. Pellissier may say, the merit of the *invention* belongs, in our opinion, to the man who, profiting by the progressive researches of his predecessors, and possessing, perhaps, far less genius, gives it to the world in an immediately available form and shows its real value.

There is, besides, another argument (not *ad hominem*, but *ex homine*), which we will finally bring forward, and which has a certain value. It is deduced from the character of the man. If Ampère was modest, Arago did not permit, and rightly, any encroachment on his domain; in fact, he defended his rights very energetically; witness his famous discussion with regard to the Barlow wheel a few years later. He knew that "those who discover a new fact in the sciences of observation must expect that it will be denied at first; that, later, its importance and utility will be disputed; then will come the question of priority; then passages insignificant, obscure, unperceived up to that time, will be brought forward as manifest proofs of the antiquity of the discovery," and whether provoked or not, he would not have failed to obtain justice for himself before his death if he had any claim whatever to the priority of the invention of the electro-magnet which had then come into general application. After having spoken of the experiments of Arago and Ampère, De la Rive says: "*Later on* it was attempted to wind *a bar of soft iron* bent in the form of a horse-shoe, with a copper wire covered with silk and wound in the form of a helix."

As to the following note by Arago on the "Principle of Electric Telegraphs," we must not forget that it is posthumous, that it does not refer to experiments of a certain date, and that, owing to its very object, it must have been edited at a much later period of his life, when the electro-magnet had entered the domain of practical application.

As regards the little publicity accorded to Sturgeon's experiments, M. Pellissier is perfectly right, the more so as Faraday, in his "Experimental Researches," attributes (1831) the electro-magnet to Prof. Moll, of Utrecht, who simply bought one of Sturgeon's from the maker, Watkins, of London. But under these conditions, we can say the same of the alleged invention of Arago, to whom Faraday might just as well have attributed it, and who would certainly have urged his claims to priority if he had grounds for so doing.

We must, therefore, my dear M. Pellissier, console ourselves for our dispelled illusions, by the hope of having jointly cleared up an interesting point in the history of science. Arago, or more correctly Ampère, may be the predecessor of the electro-magnet, but he certainly cannot be called the father of it, *since he does not appear to have ever introduced iron into a magnetising helix*, and we can render to Prof. S. P. Thompson, the first instigator of this amicable controversy, all the confidence that you rightly place in his scientific knowledge, which is generally excellently borne out by the works of scientific writers. The labours of our two great scientists are sufficient to immortalise their genius. We may shake hands over our admiration for them.

ON THE EFFECT OF A PERFORATED SEPTUM OF INSULATING MATERIAL IN THE ELECTROLYTIC PATH OF A VOLTAIC CIRCUIT.

By DESMOND G. FITZGERALD.

Prior to the sixties, when Taliaferro P. Shaffner was writing his "Telegraph Manual," the effect of introducing even a short length of fine copper wire in an Atlantic telegraph circuit was sometimes discussed, and was by some considered to be of great detriment to the chances of successful working. Poor old Richard Laming, who worked with Owen Rowland and myself in establishing the original *Electrician*, and was at one time a brilliant experimenter in electrostatics, held that the conductor should be of the same diameter throughout, and, although G. S. Ohm had already laboured and starved in the cause of science, not a few telegraphists were under the impression that the insertion of 20 yards of No. 32 copper wire in such a circuit would considerably reduce the current which otherwise would traverse the line.

In somewhat similar manner, when, some time prior to the date of my patent, No. 7,636, 1886, I first used in an accumulator a peroxide element encased in a celluloid envelope perforated with holes, there were some who held that the internal resistance of the accumulator would be very largely augmented by the presence of this envelope. "If," it was argued, "you had *no* perforations in this envelope, the resistance would be practically infinite; and if *one-half* of the insulating material is removed by perforation, you would still have twice the resistance which would be opposed to the passage of the current if you removed the envelope altogether." Writing, as I am, for those who are not mathematicians, I may point out that the former proposition is quite true, but that the latter is erroneous.

It is the resistance of only one layer of electrolyte, out of many, that would be halved by the removal of the envelope of insulating material, having 50 per cent. of its substance removed by perforation. Conversely, it is the resistance of one layer only, out of many, that is doubled by the introduction of the perforated envelope.

Taking the simple case of a prismatic mass of electrolyte of sectional area S, and length (distance between electrodes) $n\,l$, the resistance of this electrolyte may be expressed as

$$r = \frac{n\,l}{S}.$$

Even the non-mathematical reader will see that if we place vertically anywhere between the electrodes a septum of insulating material of thickness l, and originally of sectional area S, now reduced to $S - \frac{S}{m}$, so as to allow a sectional area of *fluid*, $\frac{S}{m} = s$ for the passage of the current, the resistance will be increased to

$$R = \frac{(n-1)\,l}{S} + \frac{l}{s}.$$

And he will easily see, moreover, that if $n = 100$ and $m = 2$, then the increase of resistance due to the insertion of the septum will be from 100 to 101 only.

It is true, however, that if the impervious substance of the septum were *closely* applied to an impervious electrode, the increase of resistance would be higher than that indicated. But the case under consideration is that in which the septum is applied to a porous depolarising material, saturated with the electrolyte.

I may observe that in a properly manufactured peroxide plate, no "shedding" of the active material in the condition of *fine powder* or "*mud*" should occur. Rubbing the element with the finger should have no more effect upon it than upon slate, as anyone who has handled a plate of well-made lithanode will understand.

When I gave up experimenting with the perforated envelope, it was not because I apprehended any very appreciable increase of resistance from its use, but because I thought it would be possible to construct an element with embedded conductor (and very high rate of discharge) without resorting to any device to obviate the occasional splitting of plates. Nor have I since made any use of the device in question, because it has for some time past appeared obvious to me that, in cases where very high rates of discharge are necessary, as in electric locomotion, it is of indispensable necessity to use with the acid electrolyte an absorbent, in itself electrolytic (else its resistance would be too high), so as to render the accumulator afluidic or "dry." By this means the "washing" and splashing of the electrolyte, the buckling of the plates, and the loss of active material by fracture and splitting are entirely obviated. The main difficulty in this direction is to render the absorbent sufficiently conductive; and this difficulty, I think, has now been overcome.

AUSTRALIAN ELECTRICAL NEWS.

[From our own correspondent.]

The electric light plant at Young, N.S.W., was shut down on Saturday night last from a somewhat peculiar cause. Between the time of shutting down on Friday night and 5 o'clock on Saturday evening, someone had entered the electric lighting shed and taken off and abstracted the brush carrier and brushes of the alternators. The thieves left behind a letter, written on the bottom of a cardboard box. The writing was almost illegible, but sufficient has been made out to warrant the surmise that the removal of the apparatus was intended as a reprisal on a grievance against the lighting committee of the Municipal Council. The culprit should not be hard to find, as it is evident that whoever committed the theft must have known not only how to disconnect the brush carrier, but also the resulting effects, and is presumably someone who was at one time employed in the lighting shed. A local tinsmith came to the rescue of the authorities, and managed in an hour or so to improvise brush carriers, there being, fortunately, plenty of spare brushes in stock.

Having had occasion some time ago to view a small isolated electric light plant in the suburbs of Sydney, consisting in all of about 20 16-candle-power lamps, 35 volts, I found that the main lead consisted of a No. 16 cotton-covered wire, stapled wherever its wanderings led it, the two cotton-covered wires being twisted together whenever a pendant was required. The remainder of the installation being of a similar nature, fuses were unknown. I was naturally anxious to discover the genius who had installed it, and lately there came into my possession the business card of the gentleman in question, which read as follows:— . . . . civil and electrical engineer, formerly in the service of the principal electrical engineering works, London, *and who, with Prof. Sir William Thomson, Prof. Fleming Jenkins, C.E., and others, took an active part in the manufacture and laying down of the Atlantic, East and West Indian and South American cables to Rio Janeiro, &c.*

"Electric lighting in all branches for public or private purposes.

"New buildings run with lighting wire and made ready to connect with station dynamo when required.

"*Contractor's work in this line supervised and tested for insulation, &c.*"

Judging from the sample of work that I saw, I am afraid that Prof. Sir William Thomson and Prof. "Fleming Jenkins," C.E., and others, must have sadly hindered him in laying all those cables.

Electric lighting work is still very slack, the Garden Island installation being the only one of any importance at present in view; owing to fresh political developments, there seems little hope of the Sydney Municipal Bill being passed this session.

The Brush Electric Engineering Company have just completed a small installation of 100 16-candle-power lamps at St. Vincent's Church (R. C.) and Mission House at Ashfield, a suburb of Sydney. The church is lit by a number of handsome three-light brackets placed round the walls, arranged in two circuits, each alternate bracket being on the same circuit; the conductors to the brackets are carried in vulca tubes let into the plaster.

In Melbourne Messrs. Clayton, Joel & Co., have recently fitted up the Salvation Army headquarters with electric light throughout. The building is fitted with 360 16-C.P. lamps, and two arc lamps, for photographic purposes. Current is supplied from a 200-light Manchester dynamo driven by the gas engine installed for working the printing machinery. The building is wired on the sub-distribution board principle.

Sydney, *June 24th.*

NEW FORMS OF FRICTION BRAKES.*

By W. F. M. GOSS.

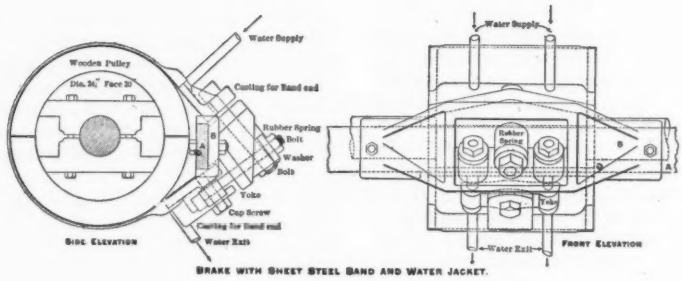
(*Concluded from page* 126.)

The brake wheel consists of a heavy split wooden pulley, 24 inches in diameter and 20 inches face. Its band is of riveted to cast iron end pieces; these are tapped for pipe connections for the jacket, and receive bolts by which the band is secured (fig. 6).

This construction provides, at very small cost, a jacketed band which is strong, tight, and flexible.

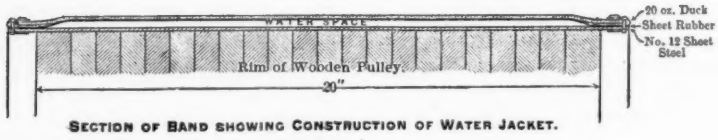
The cross-brace, A, already referred to as limiting the size of the brake wheel, is re-enforced by the flanged casting, B, and made to serve as the fixed point for the brake. The band connects with the casting, B, through the intervention of rubber springs, as shown (fig. 6). When the engine is run "over," the two outside springs receive the stress transmitted by the tight side of the band, the middle spring serving only to maintain the tension of the slack side. When the engine is run "under," these conditions are reversed. The rubber springs allow but slight movement of the band, but give to the brake all the steadiness which characterises the action of the rope dynamometer, of which, indeed, it is a type.

Steel Brake Band, with Spring.—Fig. 8 shows an absorption dynamometer which serves to load, in part, a triple-



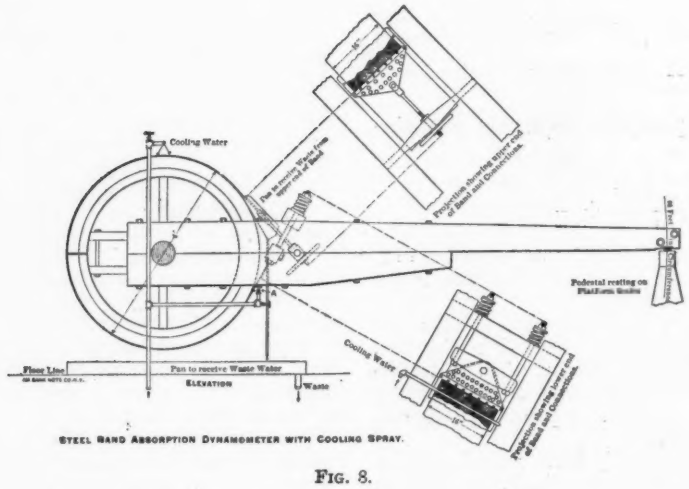
Brake with Sheet Steel Band and Water Jacket.

Fig. 6.



Section of Band showing Construction of Water Jacket.

Fig. 7.



Steel Band Absorption Dynamometer with Cooling Spray.

Fig. 8.

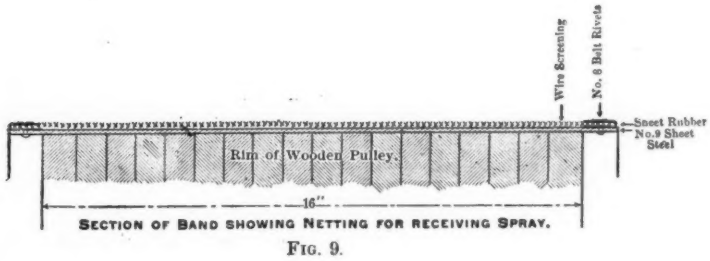
No. 12 sheet steel, and is wider than the brake wheel; riveted over it, and serving as a jacket, is a layer of rubber packing backed with a covering of stout canvas. A cross-section of the jacket is shown by fig. 7. The steel band is expansion Corliss engine. The brake wheel is a heavy split wooden pulley, 4 feet in diameter and 16 inches face. A double lever arm has bearings on the shaft on either side of the wheel, and receives the ends of the brake band. The band consists of a piece of sheet steel, to the back of which is secured a layer of iron wire netting. Water is sprayed upon the band over the top of the wheel and at a point close

* Read at the Detroit meeting (June, 1895) of the American Society of Mechanical Engineers.

under the brake arm at A. The spray is received into the interstices in the netting, and, by capillary action, is held in contact with the band which is to be cooled; the water flows in an even film over the top of the band to its under side, from which point it drops off into a pan and is drained away. A cross-section of this band is shown by fig. 9. No water reaches the brake wheel, and the band being practically always at rest, there is no throwing of water. If too little water is used steam rises from the band; otherwise, the presence of the open jacket is not noticeable. There is no annoyance from the open stream of water in the manipulation of the brake or of the engine to which it is attached.

While the performance of this brake leaves very little to be desired, its great merit is to be found in its inexpensiveness.

Alden Brakes.—This paper would be incomplete did it not contain some reference to the Alden brakes at Purdue, a complete description of which was published in the *Proceedings* of the Society for 1892.* At the time of the publication referred to, however, but little was known concerning their action, whereas they have now had three years of service.



SECTION OF BAND SHOWING NETTING FOR RECEIVING SPRAY.

FIG. 9.

Purdue's Alden brakes, four in number, are rated at 200 horse-power each, but they have been worked at higher power. Two of them have served as a load for the locomotive during 1,500,000 revolutions, which are equivalent to a distance of 5,000 miles. The other two have had about half this service. Each brake consists of a cast-iron disc 56 inches in diameter, revolving between two fixed copper plates. The space between the copper plates which is not taken by the moving disc is filled with cylinder oil, and provision is made for the circulation of the oil from the circumference to the centre of the brake; this provides for the lubrication of the rubbing surfaces. The load is regulated by water, which circulates behind the copper plates, and serves the double purpose of carrying away the heat developed and of maintaining a pressure of contact between the plates and the moving disc.

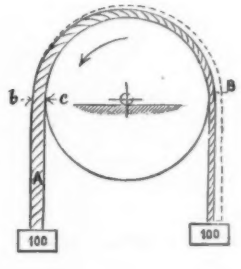
Concerning the working of these brakes, it may be said that they are frequently run at speeds as high as 300 revolutions, which speed, together with their large diameter, gives a high velocity to the surfaces in contact. The water pressure seldom exceeds 15 lbs. per square inch, which is slight compared with the ordinary pressure of bearings. There is no wear of either the copper plates or the cast-iron disc, for it is evident that while the friction is nominally between the cast-iron and the copper surfaces, the work is chiefly done upon the oil. Experience has shown, also, that, within limits, the power absorbed depends quite as much upon the temperature of the oil as upon the water pressure. Thus, if the volume of cooling water passing the brake is increased, without increasing its pressure, the temperature of the brake is lowered, the oil becomes more viscous, and the resistance offered by the brake is increased. Within limits, better results are obtained by regulating the temperature than by regulating the pressure.

These brakes furnish, for hours at a time, a resistance which is marvellously constant, and their whole action is very nearly perfect.

* "An Experimental Locomotive," Vol. xiii. See also "An Automatic Absorption Dynamometer," Vol. xi., *Proceedings* of the Society.

THE CORRECT DIAMETER OF A BRAKE PULLEY.

In the ELECTRICAL REVIEW of July 26th, 1895, appears a letter criticising our criticism of the very usual method of measuring the diameter of the rim itself as the acting brake diameter. We upheld the measurement at the middle of the brake strap itself, and our correspondent finds fault with this on the ground that where a brake strap is flexible, the centre of gravity of the weight will place itself in line with a tangent to the rim. Our remarks were not directed to denying this fact; they had reference to actual practice, not to an ideal brake strap such as is usually assumed flexible in the class room. As a fact in practice, brake straps are not particularly flexible; they are sometimes built up of blocks of wood screwed inside a strap of iron, sometimes they are of harsh rope, which is anything but flexible; indeed, where a rope is bent over a pulley, the external side is the more stretched, and must surely support quite its share of the weight. Let our correspondent try the effect of driving a 24-inch pulley by a belt from a 12-inch pulley, and *vice versâ*, and we think he will find that he does not get a ratio of 1 : 2 in the angular displacements; and this is recognised by practical men when close speeds are needed. If this be the case with thin leather belts, what must it be with ropes, or with the iron tube brake straps recently described in our columns? There is, however, one advantage besides simplicity in taking the rim diameter, viz., that in doing so the engine is made to show less duty than is really being performed. Our correspondent has evidently overlooked that brake straps of the common



variety are not practically flexible. He is, therefore, wrong, as also perhaps we were ourselves, in assuming they had no flexibility. Partial flexibility will place the true radius somewhere between the rim and the middle of the rope. The uncertainty of the question points to the desirableness of very thin steel straps for accurate trials, and also tells us that the Prony brake has one element of truthfulness, whatever its other demerits, in that the radius point of instantaneous revolution of the weight can be accurately measured. If our correspondent or anyone else has the time to do it, it would form an interesting investigation to de-

termine, with an accurately turned and balanced pulley laid on a rolling bearing, the rotative effect, if any, of two equal weights hung round the pulley by a tapering rope. According to us the pulley would revolve; but if our correspondent is correct, it will remain at rest. If, as we expect, revolution occurs, and the experiment can be verified by hanging the weights and rope upon both sides of the pulley, then the departure of the virtual centre line from the actual can be ascertained from the additional weight to be placed upon the rising side.

The accuracy of the experiment must, of course, be insured by means of a balancing rope, B, as shown dotted, to equilibrate the excess of rope on the side, A, or its equivalent; the system being equilibrated, in fact, without the weights. Is there any proof, we would finally ask, that the C G of the weight would not place itself under the more strained side of the rope at *b*, rather than under the less strained side, *c*, as suggested by our correspondent? With a perfectly elastic band, the side, *c*, is in actual compression. How, then, can it possibly sustain any tension-producing load? This is the difficulty with ropes of perfectly flexible substance, perfectly elastic. On the one hand the load hangs entirely from the rim at *c*, by virtue of its flexibility; on the other it hangs nearer to *b* than to *c*. Hence our choice of the middle position, for both the outside positions are clearly impossible, and the double assumption of the class rooms lands us in a *reductio ad absurdum*, from which the French, as quoted by us, escape by assuming the correct radius to be that of the middle thickness of the rope, and we think experimental proof alone can be offered in denial of this position.

THE NORTH-WESTERN HOSPITAL ELECTRIC LIGHTING TENDERS.

The Discrepancy Partly Explained.

The Metropolitan Asylums Board, on Saturday, definitely settled the question of the contract for wiring the five new wards and other buildings in course of erection at the North-Western Hospital. As this is the first case when the employment of conduit instead of wood casing has been prominently brought forward, the matter deserves more consideration than the amount involved in the tender would at first sight seem to warrant. As the tenders ranged from £554 to £1,557, the North-Western Hospital Committee referred them to Prof. Ayrton, the consulting engineer, to report upon.

Prof. Ayrton, in the course of his report, mentioned that when it was decided to light by electricity the new isolation block and pavilions, he applied to the Westminster Insurance Office for permission to use a conduit system. The surveyor of risks of that office, having obtained the consent of the several insurance companies who share the fire risk of the North-Western Hospital, eventually granted the necessary authority, at the same time expressing his preference for a non-metallic tube. In these circumstances, and as the details of the conduit systems are protected by patents, Prof. Ayrton considered it undesirable to specify, with minuteness, the material for the conduit, the stipulation being laid down that samples of the conduit proposed to be used by the contractor should be forwarded simultaneously with the tender. The offers received in response to advertisement were as follow, the list indicating the kind of tube tendered for:—

Name	Tender.	Material of conduit.			
		Bituminised paper.		Earthenware.	Iron.
		Plain.	Covered with brass where mechanical risk.		
	£ s. d.				
Thorpe & Waring	554 0 0	Plain.			
Electrical and General Engineering Company	649 0 0	...	Covered with brass where risk of mechanical injury.		
Thos. Mathews	650 0 0	Plain.			
Waring & Sons, Limited ...	688 15 0	...	... ...	Thick.	
Fowler, Lancaster & Co. ...	859 15 0	...	Bored steel tubes where risk of mechanical injury; rolled sheet zinc bent into tube and soldered.		
Benham & Sons	870 0 0	...	... ...	White.	
Paterson & Cooper	895 0 0	Plain.			
Julius Sax & Co., Limited ...	944 8 9	...	... ...	Doulton's.	
J. C. Howell, Limited	981 16 4	Plain.			
London and Lancashire Electric and General Engineering Company, Limited	1,050 0 0	...	... ...	... ...	Complete iron system; iron sockets for switches, &c.
Miller & Woods	1,070 0 0	...	... ...	... ...	Iron.
Sharp & Kent	1,098 0 0	...	... ...	... ...	Ordinary gas barrel.
Taylor Smith Electrical Company, Limited	1,124 0 0	Plain.			
Roger Dawson, Limited ...	1,140 0 0	...	Covered with brass where risk of mechanical injury.		
Hayward, Tyler & Co.	1,340 0 0	...	... ...	... ...	Complete iron system; iron sockets for switches, &c.; pipes coated with Angus Smith's compound.
V. C. Middleton	1,440 0 0	...	... ...	... ...	Iron.
Vaughan & Brown, Limited ...	1,557 0 0	...	... ...	... ...	Ordinary gas barrel.

As a result of his examination of the tenders and sample tubes, Prof. Ayrton recommended the acceptance of the offer of Messrs. Fowler, Lancaster & Co., Limited, for £859 15s. The reasons for this recommendation are, briefly, as follows:—1. The zinc tubes are much stronger than those made of bituminised paper, and will stand the action of damp and cement better than paper. 2. Zinc is stronger than earthenware, unless the latter be very thick, and it can be obtained in greater lengths, and also be joined more easily. 3. As the company are prepared to use steel tube where there is special risk of mechanical injury, their system is nearly as good as one in which iron pipes are employed throughout. 4. The company's tender is nearly £200 less than the lowest of those in which iron pipes are quoted for, and is only £300 more than the lowest tender of all; and as the latter is for a simple paper tube, its adoption is not to be recommended. 5. As the zinc tubes are made out of rolled sheet, and as the steel tubes are smooth inside, there is far less risk of damage to the insulation of the leads in drawing in than if rough gas barrel were employed, as is contemplated in some of the higher tenders.

When the matter was discussed at the meeting of the board on Saturday, the opinion was freely expressed that the tubes should, wherever possible, be exposed rather than be concealed. This view of the question was adopted, and the board accepted the tender of Messrs. Fowler, Lancaster and Co.

ON A LOW-RESISTANCE "DRY" ACCUMULATOR.

By DESMOND G. FITZGERALD.

From one point of view the publication of the following "workshop" notes may be considered premature. It may be pointed out that the experiments would need to be continued for many months in order to prove anything conclusively from a practical point of view. This is quite true; and I should, myself, object to any present conclusions as to so much, or so little, being possible. For I may observe that careful experiments on a very small scale *have* been going on for very many months, and that some results have been obtained which I consider to be altogether more favourable to the new system than those now published. The latter, I think, show that a mistake was made by adding an insufficient quantity of acid to the contents of the "dry" cell. On the other hand, I believe I may fairly say that nothing of the kind approaching these latter results in what I may call *primâ facie* practical interest has ever been published or obtained. The current from a "dry" accumulator has, in general, been mainly conspicuous by its absence. It has usually been impossible to obtain from the latter the normal "maximum rate of discharge" allowed by the manufacturers—to say nothing of a rate of discharge twice as great.

To the question: "How do you know that cell 'B' has not been disintegrating as fast as or faster than cell 'A?'" I can only, just at present, reply by a reference to the apothegm "Safe bind, safe find!" In the case of cell "B," the plates are so tightly packed in the absorbent material that it becomes difficult to imagine how disintegration can take place.

The impeded circulation of the electrolyte in the case of a "dry" cell is one of the main difficulties to be encountered in this direction. A rest for a minute, if it were permissible, would be more refreshing to the harnessed mystery of an electric tramcar than to the jaded animals ordinarily attached to the vehicle. It is curious, in the following experiments, to observe how quickly the E.M.F. "picks up" by the effect of a little rest.

Notes of Experiments in Connection with Fitz-Gerald's System of Working Accumulators with an Absorbed Electrolyte, or Converting Them into So-called "Dry" (Afluidic) Cells.

The experiments were made with E.P.S. (E 7) accumulators, with lead-lined wooden boxes. The various observations and operations were made and carried out by Mr. R. J. Jocelyn-Swan.

No steps were taken on these occasions to subject the accumulators to shocks and vibration.

One of the accumulators (A) was used as sent out (charged) by the E.P.S. Company.

In the other (B) the usual acid was replaced by an absorbent saturated with electrolyte and having the appearance of a nearly dry cake.

Cell A weighed 24 lbs. 13 ozs.
Cell B weighed 26 lbs. 2 ozs.

According to the instructions supplied by the E.P.S. Company, the maximum rate of charge of the E 7 cell is 12 ampères, and the maximum rate of discharge 13 ampères.

On July 16th, 1895, the cells A and B were connected in series and charged with a current of 13 ampères for about 30 minutes, when the plates in cell A evolved gas freely.

The E.M.F. was then:—

(A) 2·14 volts falling to 2·11
(B) 2·20 „ „ 2·19

The cells, being still in series, were discharged at 13 ampères during 1 hour.

Just before the expiration of this period the P.D. at the battery terminals respectiively were:—

(A) 1·90 volts.
(B) 1·82 volts.

The E.M.F. taken immediately after the hour's run were—

(A) 1·92 rising to 1·95
(B) 1·96 „ 1·99

On the following day the discharge in series was continued, the initial E.M.F. being:—

(A) 1·98
(B) 2·0

The discharge current, commencing at 18 ampères, was increased (by adjusting resistance) to 19 ampères. At the expiration of 16 minutes the P.D. were:—

(A) 1·81
(B) 1·75

The current was now finally increased to 20 ampères. When the discharge had been continued for 56 minutes (from the commencement of the present discharge) the voltmeter indications were:—

(A) P.D. at terminals 1·79
(B) „ „ 1·51

This (second) discharge was continued for 1 hour. Just before stopping the P.D. were:—

(A) 1·79
(B) 1·40

Five minutes after breaking the circuit the E.M.Fs. were:—

(A) 1·87
(B) 1·72

Second Charge of Cells in Series.

The cells were then charged at 12 ampères for 3 hours. After 2 hours 45 minutes the P.D. were:—

(A) 2·4 volts.
(B) 2·6 „

On breaking circuit the E.M.F. were:—

(A) 2·1 falling to 2·02 volts.
(B) 2·2 „ 2·11 „

A discharge of 20 ampères for 1 hour was then taken. After 30 minutes the P.D. were:—

(A) 1·90
(B) 1·85

After 45 minutes:—

(A) 1·89
(B) 1·80

Just prior to the hour:—

(A) 1·85
(B) 1·72

Five minutes after breaking circuit the E.M.F. were:—

(A) 1·94
(B) 1·91

Third Charge of Cells in Series.

On July 18th, the cells were charged for 3 hours at the normal rate of 12 ampères.

Then a discharge was taken for 1 hour as follows:—

A current of 30 ampères for 3 minutes.
Then 20 „ „ 17 „

Just before the expiration of the 20 minutes the P.D. were:—

(A) 1·90 volts
(B) 1·87 „

Again, a current of 30 ampères was taken for 3 minutes. The P.D. at 30 ampères was:—

(A) 1·85 volts.
(B) 1·79 „

For the second time a reduced current of 20 ampères was taken for 17 minutes. P.D. after the 40 minutes run:—

(A) 1·85
(B) 1·78

A third "spurt" of 30 ampères for 3 minutes. P.D. at 30 amps.:—

(A) 1·82
(B) 1·70

Lastly, a current of 20 ampères for 17 minutes was taken for the third time. The final P.D. were:—

(A) 1·80 volts.
(B) 1·65 „ Stopped.

After 5 minutes the E.M.F. were:—

(A) 1·90
(B) 1.87

There were little or no indications of damage to cell A by these heavy discharges.

Fourth Charge of Cells in Series.

On July 18th the cells were again charged at 12 ampères for 3 hours. The E.M.F. were then:—

(A) 2·05
(B) 2·10

A discharge was taken for 1 hour,* as follows:—

30 ampères for 3 minutes.
Then 20 „ 17 „ (as before).

The P.D. after the 20 minutes was:—

(A) 1·90
(B) 1·87

---

* One hour is taken as economically the maximum duration of a tram or road trip without renewal of power.

Again, 30 ampères were taken for 3 minutes. P.D. at 30 amps.:—

(A) 1·85
(B) 1·79

Then, 20 ampères for 17 minutes. P.D. after 40 minutes run:—

(A) 1·85
(B) 1·78

Again, 30 ampères for 3 minutes. P.D. at 30 ampères:—

(A) 1·82
(B) 1·70

Lastly, again, 20 ampères for 17 minutes. Final P.D.:—

(A) 1·80
(B) 1·65. Stopped.

E.M.F. 5 minutes after discharge:—

(A) 1·90
(B) 1·87

Fifth and Sixth Charges of Cells in Series.

On July 19th the cells were twice charged and discharged; the first discharge being at 22 ampères with 3 minutes "spurts" of 30 ampères, and the second at 25 and 30 ampères.

First discharge. Initial E.M.F.:—

(A) 2·03
(B) 2·10

22 ampères taken for 17 minutes; 30 ampères taken for 3 minutes. P.D. at 30 ampères:—

(A) 1·89
(B) 1·79

Again, 22 ampères for 17 minutes. P.D. at 22 ampères (end value):—

(A) 1·89
(B) 1·76

Again, 30 ampères taken for 3 minutes. P.D. at 30 ampères:—

(A) 1·87
(B) 1·67

Again, 22 ampères for 17 minutes. P.D. (end value):—

(A) 1·85
(B) 1·56

Lastly, again, 30 ampères for 3 minutes. P.D. at 30 ampères (end value):—

(A) 1·83
(B) 1·35. Stopped.

E.M.F. 5 minutes after breaking circuit:—

(A) 1·91
(B) 1·85

N.B.—On examining the elements of cell A, it was observed that some of the pellets of active material (peroxide) had become detached from the grids, and that near the edges of the latter there were a few patches of active material above the level of the surrounding surface and showing signs of disintegration. The plates were otherwise in good condition.

Second Discharge on the Same Day.

After the cells had once more been charged in series the E.M.F. were:—

(A) 2·09
(B) 2·12

A current of 30 ampères was first taken for 3 minutes.
Then 25 „ „ 17 „

P.D. soon after starting at 25 ampères:—

(A) 1·88
(B) 1·88

Again, 30 ampères were taken for 3 minutes. P.D. at 30 ampères:—

(A) 1·86
(B) 1·80

Then again, 25 ampères for 17 minutes. P.D. at 25 ampères:—

(A) 1·83
(B) 1·73

Again, 30 ampères for 3 minutes. P.D. at 30 ampères:—

(A) 1·81
(B) 1·68

Lastly, 25 ampères for 17 minutes. Final P.D.:—

(A) 1·80
(B) 1·60. Stopped.

E.M.F. after five minutes:—

(A) 1·95
(B) 1·88

July 20th.—As it was evident and admitted that cell A would soon be destroyed if worked at such high rates of discharge, the experiments were continued with cell B only. After charging at the usual maximum rate this cell showed:—

E = 2·15

A current at 30 ampères was first taken for 3 minutes.

Final P.D. 1·93

A current of 25 (25·5) ampères was then taken for 17 minutes.

P.D. (end value) 1·88

32 ampères were then taken for 3 minutes.

P.D. 1·80

Then 26 ampères for 17 minutes.

P.D. (end value) 1·71

32 ampères were then taken for 3 minutes.

P.D. 1·60

A current of 27·5 ampères was then taken, but could not be maintained for the full remaining period of 17 minutes; the current falling to 21 ampères. Stopped.

E.M.F., 5 minutes after breaking circuit, 1·85.

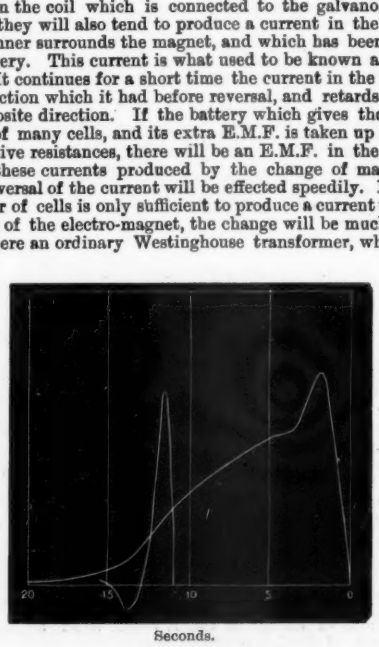
Mem.—Absorbent too dry—add more acid.

THE EFFECTS OF ELECTRIC CURRENTS IN IRON ON ITS MAGNETISATION.*

By JOHN HOPKINSON, Esq., M.A., D.Sc., F.R.S., M.R.I.

Let us recall a well-known experiment of Faraday's. Upon a ring of iron is wound a few turns of copper wire, through which may be passed a current. On it is also wound a second coil, the ends of which are connected to a galvanometer. It was known that when a current is passed through the first-named or primary coil, the ring becomes a magnet, and that if the current is reversed in direction, the magnetisation is also reversed. Faraday showed that when the magnetism is reversed, a transient current is caused in the second coil. The current which is reversed is a measure of the magnetising force; the total amount of current caused in the second coil by the reversal is a measure of the induction of the magnet. The current in the second coil is opposed in direction to the current in the primary after reversal—that is, it is in the direction of the current before reversal. If the changes in magnetisation in the iron produce a current in the coil which is connected to the galvanometer, it is clear that they will also tend to produce a current in the coil which in like manner surrounds the magnet, and which has been connected to the battery. This current is what used to be known as the extra current. It continues for a short time the current in the battery coil in the direction which it had before reversal, and retards its change to the opposite direction. If the battery which gives the current is a battery of many cells, and its extra E.M.F. is taken up by ordinary non-inductive resistances, there will be an E.M.F. in the battery to overcome these currents produced by the change of magnetisation, and the reversal of the current will be effected speedily. If, however, the number of cells is only sufficient to produce a current through the resistances of the electro-magnet, the change will be much slower.

I have here an ordinary Westinghouse transformer, which has an



Seconds.

Fig. 1.

electro-magnet in the ring form; but the iron of its core is divided into thin plates for the purpose of preventing currents in the iron itself. There is upon it a primary coil connected to the battery, and a secondary coil connected to the galvanometer. I will first show you the effect produced when a battery current is produced by a battery of one cell giving about 2 volts. You observe that the current induced in the secondary coil takes a somewhat long time for its production, and for its subsequent diminution—about 15 seconds. I will now connect it to a battery of high E.M.F., or rather to the mains which supply current to the building, and we will repeat the experiment with the same current in the primary coil. Observe the difference. The current increases more rapidly and dies away very much more quickly, taking in all about three seconds instead of 15 seconds, as before. I should perhaps here state that the sensibility of the galvanometer has been altered between the two experiments, so as to give a deflection of convenient size to be observed upon the screen. In the first case it is very much more sensitive than in the second. Exactly the same experiment can be shown to you in another form.

* Lecture delivered before the Royal Institution, April 26th, 1895.

These galvanometer deflections can be exhibited in the form of curves, in which the abscissæ represent times, and the ordinates represent the deflections. The curve which I am showing you (fig. 1) has actually been taken as a photograph, the plate being moved across the field with uniform velocity. On the same plate you see the curves which have been obtained with a larger E.M.F., and with a smaller one. The times at which the reversal occurred in each case are marked by the sudden change at the beginning of the curve. You see exactly the same thing as you saw upon the screen; the big battery makes the changes occur rapidly, the small battery allows them to occur more slowly. The dip of the curve for the large battery beyond the axes of the ordinates is not a real part of the phenomena. It is caused by the momentum of the moving part of the galvanometer.

In these experiments the iron has been divided in order to get rid of the particular effect about which I wish to speak this evening. Iron, as everybody knows, is a good conductor of electricity, not so good as copper, but still much better than any other substance than the metals. In a magnet, then, with a solid iron core, the outer portions of the iron are in a similar position to the copper coils surrounding the iron. On reversing the magnetising current, currents will be induced in the iron, and these currents will delay the changes of

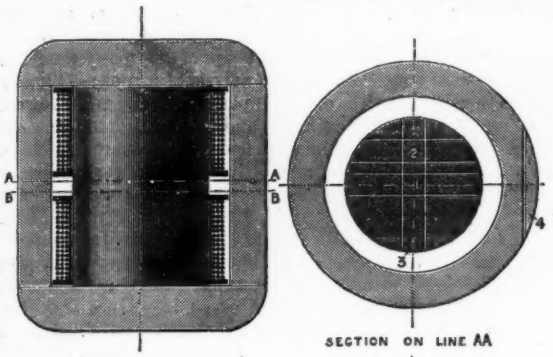
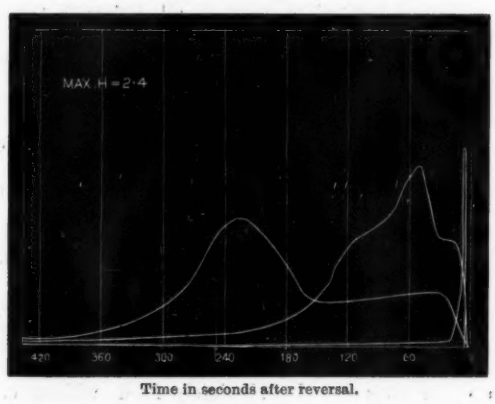


Fig. 2.

magnetic induction within them, and they will delay them the more the deeper in the iron is the point under consideration. I have in the room below a large magnet, which has been expressly constructed for the purpose of investigating the changes of induction which occur at different depths in the iron when the magnetising current is reversed. It is shown diagrammatically in fig. 2. One view represents the vertical section of the magnet, the other the horizontal section. The magnet consists of a central cylinder of iron surrounded by an annulus with a large slab of iron at each end for the purpose of completing the magnetic circuit. Between the central cylinder and the annulus are placed the magnetising copper coils. In the solid cylinder holes are drilled at right angles to each other, and these holes meet within the iron. A strand of copper wire has been drawn in through the holes, and has subsequently been connected up so that the coils of the strand are in series with each other. In this way we

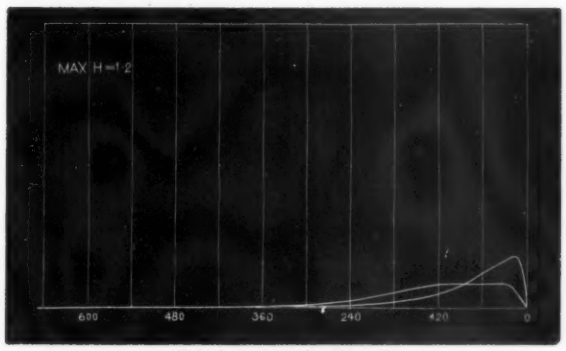


Time in seconds after reversal.

Fig. 3.

have a coil surrounding a portion of the iron at 3, at 2, and at 1, of approximately the same area. If these coils then are connected to a galvanometer, they will measure the changes of induction which occur in the areas 3, 2, and 1, enclosed, and we shall be able to show you the times at which the currents in the iron permit the effect of reversal in the copper coils to be manifest. We have, in addition, a coil, marked 4, in the outer magnet. Now, when the currents in the large copper coils are reversed, the magnetism or the induction in the coils 1, 2, 3, and 4, will also be reversed, but more slowly, and currents will be induced in these coils. I propose to show you the way in which these currents occur, and are modified by the currents in the iron. We shall see that the changes in induction induce currents in the iron, and that these in their turn delay the changes in induction.

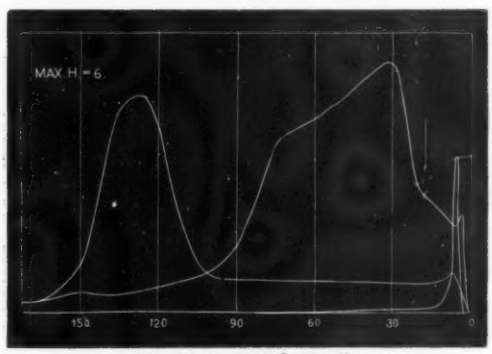
In order to give you a better idea of what is happening, we have provided three galvanometers. The galvanometers throw their images upon the screen at different altitudes. Now, what I want you to observe is this—that the disturbance of induction in the outermost coil occurs immediately upon reversal of the current, and it occurs after some time in No. 2 coil, and after a much longer time in No. 1 coil, and also to observe the difference of the effects according as the magnetising current is large or small. In all these experiments a



Time in seconds after reversal.

Fig. 4.

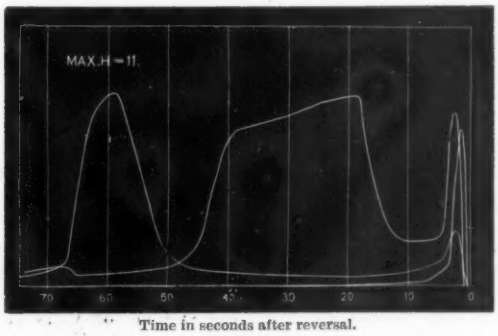
considerable battery power is used, and its excess of E.M.F. is taken up with non-inductive resistances consisting of lamps; that is in order to confine the effects to the currents in the iron, and to get rid, as far as possible, of the effects of induction in the copper coils themselves. We will begin with a somewhat low force, 2·4. You notice that, as shown in fig. 3, the galvanometer of No. 3 coil is promptly deflected, and as promptly returns to zero, because there



Time in seconds after reversal.

Fig. 5.

is no depth of iron outside it in which currents can circulate. No. 2 coil soon moves off to a substantial deflection, and presently, after 50 seconds have elapsed, it moves off to a greater deflection. The behaviour of No. 1 coil is not dissimilar, but it takes much longer. As in the case of the transformer, the same thing can be shown as a curve (fig. 3). Observe the relation of currents in the exploring coils to time. No. 3 coil rises to a maximum, and at once ceases.

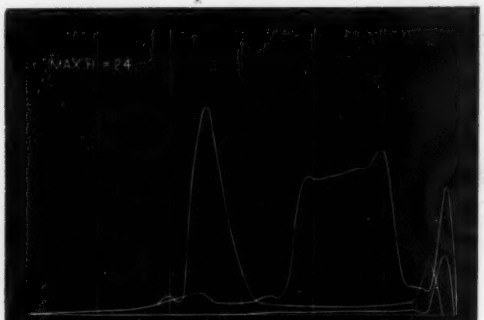


Time in seconds after reversal.

Fig. 6.

No. 2 goes off fairly rapidly, dwells for a time, and then rises to a full maximum at about 50 seconds; whilst No. 1 coil goes through the same events, but more slowly, as is shown by the increased abscissæ taking four minutes to reach its maximum. Here is a curve (fig. 4) for a lower force, 1·2, half of the last: notice how great the difference—the maximum is reached much more speedily and the currents drop more slowly. Take

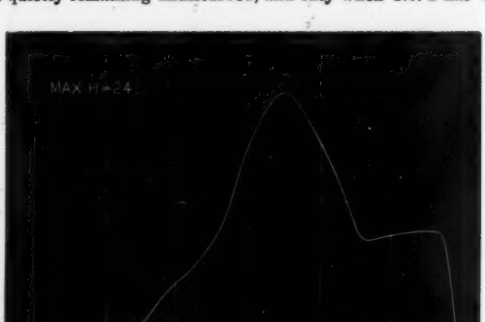
a somewhat higher force, 6·0, to see its effect on the galvanometers. The sensibility of No. 3 galvanometer is much less than that of Nos. 2 and 1, which are about the same. You see a new phenomenon develop: there is a first maximum in Nos. 2 and 1 coils, followed by a dwell and then a rise to a second maximum. Look at the corresponding curves (fig. 5). The maxima are occurring earlier than with the force of 2·4—that for No. 2 coil at 30 seconds instead of 50 seconds, and of No. 1, the centre coil, at 130 seconds instead of 240. Again take a higher force, this time 11 (fig. 6): see how marked



Time in seconds after reversal.

FIG. 7.

the first rise has become. On the curve notice that the maximum of No. 1 coil is as great as No. 2—with lower forces it has always been less. The highest force I shall show you is 24 (fig. 7), and it is really the prettiest. The first maxima occur markedly at once. No. 2 coil comes down to a small value, then rises to a substantial maximum in about 10 seconds, remains near its maximum value for 10 seconds, and passes away. Whilst No. 2 has been at its maximum, No. 1 has been quietly remaining undisturbed, and only when No. 2 has quite



Time in seconds after reversal.

FIG. 8.

finished does No. 1 suddenly move off to a maximum greater than No. 2 at 35 seconds and then very suddenly disappear. We must not leave this part of the subject without showing one experiment with No. 4 coil, which is placed in the annular part of the magnet. We will use the maximum force (24). The general character of the changes is the same as before, but in this case the magnetism changes at once in the interior of the ring, and later at parts nearer to the outside. You see the same thing from the curve, fig. 8.

(To be continued.)

PAYMENT ON A PIECE RATE SYSTEM.

THERE was suggested at the Detroit meeting of the American Society of Mechanical Engineers, as a step toward a partial solution of the labour problem, a system of piecework. The author, Mr. F. W. Taylor, of Philadelphia, states that he has employed the system for years at the Midvale Steel Works, and that it has been effectual. He remarks very truly that piecework, as ordinarily carried out, involves a permanent antagonism betwixt employer and employed, because the worker, when he attains a high efficiency, usually suffers a reduction in his wages, and the invariable result is that the worker settles down to a rate of work beyond which he will not go, for the obvious reason that if his earnings are increased, his rate of pay will be cut.

Mr. Taylor's system does not strike us as altogether satisfactory. It might result in advantage could it be carried out; but few can carry out a system which is so complex as to demand an elementary rate fixing. The system consists of two main principles, an elementary rate fixing department, and a differential rate of pay for piecework.

The differential rate idea is simply the payment of a higher rate per piece for, say, 20 articles done per unit of time, than for 15 or 10, or any less number than 20. The man who can only do five receives less than a quarter of the pay of the man who does 20. There may be a Scriptural flavour about the business, but it does not strike one as particularly humanitarian. The elementary rate fixing is the crux of all systems of piecework, and the author would have rates fixed less on haphazard and more by rule than is in vogue at present. For this purpose, he would keep full records of the time required to perform elemental or preliminary work, and would deduce therefrom the rate to be paid for any particular piece of work which he avers, can be assumed as built up of so many elements. Thus he suggests the following analysis of labour:—Time to lift piece from floor to planer table, to level and set work true on table, to put on bolts and stops, to remove same when done, to lift piece back to floor, to clean up machine. That is the work done by man; then follows work done by machine:—Time to rough-cut ¼-inch deep, 4 feet long, 2½ inches wide, to rough-cut ¼-inch deep 3 feet by 12 inches, to finish first cut, to finish second cut, per cent. for unavoidable delays. It is held that the man who fixes rates soon becomes able to estimate such elements quickly; but this is, to our mind, the most difficult thing to do. Once this were done, a rate fixed and adhered to, there would be little trouble with piecework. It is in fixing the rate at once, and not too high, that the difficulty comes in, but there is no need of the differential rate to urge men to work at their best. They will always do this if they know they are not to be cut. Here is a case in point. An American invention was brought to this country, and piece rates fixed for its manufacture. Some American workmen were also brought over, and given the same rates as they received in America for doing the work, and they worked so as to earn twice the money earned by the English workman. An American engineer held this up to us as an example of the superiority of the American workman. It was nothing of the sort. The Americans worked to make a wage such as they needed to live upon in America; the piece rates enabled them to do this. The English workers, finding that the piece rates were good, did not exert themselves to earn as much as the Americans, for the simple reason that had they done so they would have experienced a 50 per cent. cut next week. They worked, therefore, just so hard as would earn them as good living in England as the Americans earning double money could secure in America, and they did not allow themselves to be bluffed out of their half speed by any jeers as to their presumed inferiority. The mistake was made in the original rate fixing. Had it been fixed at one-half, the men would have simply worked harder and earned a living. The prevalent idea among workers is simply that employers wish to get all they can out of their workers, and do not wish to pay a farthing beyond sustenance. Without prejudice towards either side, we fail to see how the conflicting interests can be reconciled much better than they are at present. Co-operation, the differential plan where it can be worked out on a sound rate fixing system, or profit sharing, all meet the difficulty to a limited extent in certain environments, but piecework is itself no solution of the difficulty, even where rates can be absolutely fixed without error. Where this can be done, the rates themselves form the bases of quarrels. Take the various machines in a cotton mill, where certain machines are driven at a steady uniform rate by an engine of almost absolutely uniform speed for a given time daily. The raw material is supplied to the machine of a certain average weight and quality, and is drawn through the machine at a given rate. The one duty of the machine minder is to keep all the threads up, and the skill in doing this, in removing full bobbins and substituting empty ones, is the one thing needful. Payment is made on the number of revolutions of one of the shafts of the machine, named the front roller.

The only deduction from the maximum pay is that due to stoppages caused by bad material. The duty of the foreman

is to see that machines are not run with ends down, for this diminishes production, and cannot be allowed to proceed many revolutions, because it stops the possibility of producing on that one spindle until the next refill of empty bobbins. Here is an ideal piece system absolutely calculable, but will anyone say there is no opening for dispute? Nevertheless, though we doubt the special value of the differential system, we think that, if it is possible to be done, there should be prepared a hand-book of speeds of work which should describe the methods of making and recording the necessary observations in rate fixing. We refer, of course, to engineering and similar workshops. Where, as in a shop devoted entirely to one class of work, there is a continued repetition of the same thing, the fixing of piece rates by some such system as suggested may not be so difficult, but the variation in hardness of cast-iron and numerous other factors must always enter into the problem very considerably.

Where work is conducted leisurely, the hardness factor is not of much account, but where rates are based on the speeds possible with soft cast-iron, the use of a harsher material will always reduce the maximum possible speed and fulness of cut. That this is so, is plainly seen in the curious criticisms passed on English tools by Americans who, accustomed to soft material, cannot imagine a harsh one, and ascribe our strongly built tools to our ignorance and innate clumsiness. If material differs so widely, the fixing of rates must always be a matter of some difficulty, and we fancy that where it has been accomplished to the satisfaction of all concerned, the outside world hears little of it, as a rule, and that there are shops where, in process of years, things have been pretty well thrashed out on some such lines as Mr. Taylor indicates. During the learning period, however, there must always be a lot of difficulty in getting to a correct knowledge of the possible maximum rate of work of the machines.

It is chiefly in electrical work that the question will interest our readers. The principle of piecework so far as this relates to increased returns from plant may with comparative ease be applied to the payment of premiums for good returns. The ratio of electrical output to the coal consumption forms a very suitable ratio on which to pay a premium. So also does the oil consumption, the premium being reduced for each hot bearing as a safeguard against meanness, and even the repair account may be saddled with a charge upon the amount it falls below a usual percentage; and it is easy to correlate the fuel bill with the water meter, while the output at the central station and the meter returns of the consumer might by means of a premium be brought into closer coincidence by linesmen's care. We wonder if gas companies do this? Their consumers' meters always seem to run very fast as though trying to outrun the work's meter.

These above premiums and others similarly based are easy to fix because there are so many data that may be used to fix fair rates, which is not the case in machine tool work.

The system of profit sharing is very usually condemned by those who advocate piecework, yet it appears to have its field. If we are to judge from the accounts in the daily papers, the South Metropolitan Gas Company seem to be getting along with their men very well on the line of profit sharing. The workers seem to have accumulated some £60,000 during six years as the result of the scheme. A gas works, however, which starts the system has the advantage that it need never stop it. They have such opportunities of squeezing another ten or fifty thousand out of the public by increased charges, or of saving at the works by reduced cleansing of the gas, or a reduction of lighting power, that the great bane of profit sharing—viz., a year with a loss, never occurs.

THE CIVIL ENGINEER.

Commenting upon the address of Mr. G. S. Morrison, President American Society of Civil Engineers, in June last, our contemporary, *Engineering*, awards praise to the Institution of Civil Engineers for setting its authority against the perversion of the term civil engineer. We all know that not long ago the man who could use a level and watch clay shovelled into a barrow and wheeled to a tip, arrogated to himself the title of civil engineer, and denied it to the man who could design a Bessemer plant, a locomotive or the steam plant and mill work of a huge factory, and one could not even look in at No. 25 without the clay brand. Somewhat the same spirit existed also at one time in the American Society, but not to the same extent, though for a long time the Society used, as a badge, a miniature theodolite or level. The indefatigable secretary of the English Institution, Mr. Forrest, however, never let the opportunity pass of protesting steadily against the narrowing of the term, and civil engineering has become the generic term it should be of the profession of engineering as carried on by men who are not military engineers. Rankine rather narrowed the meaning of the term by his work on civil engineering, in which he restricted himself almost entirely to the consideration of works of communication, water supply, drainage, or surveying, and to-day the post of engineer to a local board falls to the lot of the mere surveyor far more readily than to an engineer whose attainments are much higher, but whose practice has been more in mechanical subjects. The harm that has been thus done to the country at large is incalculable, and we have seen numerous instances where thousands of pounds have been spent on public undertakings, where as many hundreds would have secured far better results.

The shutting of themselves up to a single man, as spoken of by *Engineering* as a trait of directors and others responsible for public works, is often painfully manifested. We have now before us, as we write, the papers concerning a public work in a country town which was being urged upon the local authority by the Local Government Board. Certain works were carried out by the local authority, and then the matter was put into the hands of an engineer, who at once abandoned everything that had been done, and started *de novo* upon new works at an immense cost, in such a manner that they were never satisfactorily finished. This was a case for a specialist, and we are very much inclined to the opinion that the omniscience of the great man, who knows everything from a locomotive or bridge design to a canal, harbour, or railway, is a delusion and a snare. On the other hand, we know of engineers in high positions who are not ashamed or afraid to consult with the specialist engineers of contractors, and thereby secure for their patrons better and cheaper results, and for themselves the respect of all who meet them. Such are, perhaps, the men whose chief capacity is in dealing, as our contemporary says, with their fellows. There is room for them; we wish more were to be met with. Of all difficult men to deal with, commend us to the engineer whose training has been in the narrow lines of the civil engineer of Rankine. We mean no disrespect to Rankine, but wish to indicate merely the line of training. Unacquainted with mechanical work, completely at a loss in hydraulic work or steam, such a man, be he a railway or a canal man, has often less ability to understand the simplest a, b, c, of other work than the uninstructed layman. He is neither a master of men nor of materials, and woe to the contractor who falls in his way, and is compelled to spoil good work rather than depart the width of a red tape from a specification. We would not worship *technique*, described as the pitfall of specialism, but we would ask engineers to make themselves somewhat acquainted with methods of to-day when specifying for work. Unfortunately effects are gained in engineering that are well worth looking at, and yet which are extravagant and unnecessary, and constitute a heavy perpetual charge on the rates that a little knowledge of *technique* would have avoided. The narrowness of the technical student is not quite *apropos* of this question. His professor may be, probably was, inexperienced, but the student will broaden if he has the mind for it. While on the subject of professors, however, it may not be out of place to call attention to a somewhat prevalent opinion abroad, that the portals of engineering institutions are more freely open to the professor, no matter how fresh or inexperienced, than to men of sound practical training and good judgment, whose ability falls short of the professors on the blackboard or in the mathematical gymnasium alone, and exceeds it in all other directions. We do not think the prevalence of this opinion should be allowed to continue if it can be checked. The man of practice and of good education does not relish being relegated to a lower grade than a mere teacher who has done next to nothing of practical work. The professors are now

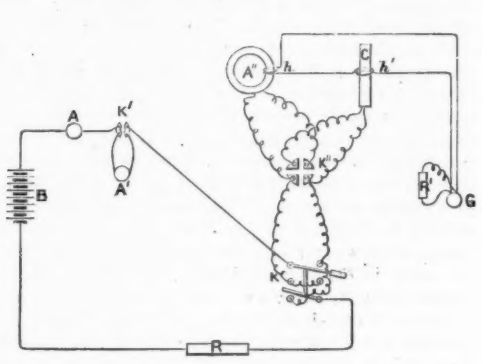
so numerous that we shall be held free of the charge of selecting any one in the above remarks, but we feel bound to put in a word for the non-professing men, who are hardly occupying their rightful positions. It will be a mistake if college work is allowed to take precedence over work in the field, shop, or office. Engineers cannot be made in the class room, nor as a rule are very young men safe guides. There is that in experience which teaches men where they must draw the line in their excursions into the novel and untried. Of late years, the overstepping of this line has been a little too frequent, and it has largely arisen out of the attempt to manufacture engineers fully fledged. It is worthy of remark that the original civil engineers, using the term in the restricted sense, of this century, were largely mechanical engineers. Such were the Rennies, for example. Our contemporary urges engineers not to be too anxious to become leaders of men in the sense of being able to influence boards and corporations. We have lately seen such ability outstep the etiquette of the profession in a very lamentable manner. Let engineers be content to direct the forces of nature with intelligence as befits their profession.

THE MAGNETIC QUALITIES OF FORGED STEEL.

As has long been known, the magnetic value of wrought-iron is several times greater than that of cast-iron, and the magnetic behaviour of each of these metals, as well as of steel, is so dependent upon its chemical constitution, physical properties, and treatment during manufacture, that tests of the magnetic qualities of iron for electrical machinery have risen to the importance of "tensile strengths" and "elastic limits" in civil engineering operations. Only recently Prof. Ewing has made a large number of tests of samples of iron rings, submitted by different manufacturers, which will undoubtedly prove of great service to electrical engineers, as well as to the manufacturers themselves.

The question of the magnetic qualities of steel is becoming of very considerable importance in connection with artillery. In designing apparatus for some experiments which were to involve the use of the steel employed in the manufacture of heavy guns, under the influence of magnetising electric currents, it was recently considered desirable, by the authorities of the United States Artillery School, to ascertain something of the qualities of this steel, in a magnetic sense, in the actual final condition in which it exists in the finished gun. A series of tests was consequently elaborated, and the execution of them was entrusted to George O. Squier, Ph.D., first lieutenant, Third Artillery, U.S.A., who carried them out in the laboratory of the Johns Hopkins University. The tests were evidently made with considerable care, and as some of the results may be of use in case similar data are required in the future, which seems not improbable in view of the rapid advance now being made in the utilisation of electrical power for controlling heavy cannon, they have been recorded in Vol. iii. of the *Journal* of the United States Artillery, pp. 559—575.

A ring of steel was cut from the muzzle of a 8·2 breech-loading rifle cannon, furnished by the Watervliet Arsenal, and used in the experiments. This steel was a low steel of remarkable physical qualities; it had been forged, oil-tempered, and annealed. The method of examination employed was distinctly interesting. The sample being in the form of a ring, the ballistic process, which is a modification of Rowland's method (*vide Phil. Mag.*, 1873, Vol. xlvi.), was employed. Rings possess the advantage of furnishing closed magnetic circuits without poles or leakage, while they have the disadvantage of being difficult to wind as compared with bars. With the ballistic method a transient induction current is generated in an exploring coil which surrounds the ring of iron, and the integral of this current is proportional to the "throw" of a ballistic galvanometer needle in circuit with the ordinary D'Arsonval instrument with telescope and scale, and was made ballistic by weighting the mirror with a long wooden arm supplied with a metal bob at either end. The galvanometer was calibrated by sending, successively, currents of increasing strengths through the primary of the standardising coil, and observing whether the "throws" varied in a corresponding manner. The accompanying diagram shows the arrangement of circuits:—



We shall now describe the method somewhat in detail, inasmuch as it may be found to be of service to many of our readers.

The source of energy, B, was a bank of storage cells. K is a reversing switch; R, an adjustable resistance, arranged so that certain definite amounts could be introduced or taken from the magnetising circuit without break; A, a standard Weston ammeter; A′, a standard Weston milliammeter in series for the accurate measurement of small values of the magnetising current; K′, a cut-out switch, which allowed the milliammeter to be taken from the circuit without break when the current rose beyond its range; A″, the specimen ring, which was wound with two coils, a primary and a secondary. The ring being first covered with Okonite tape, the secondary coil of fine wire (No. 28) was wound over its entire circumference, and consisted of 200 turns. The secondary was wound inside the magnetising circuit instead of outside, as is usually done, to avoid any error due to air space. Over this secondary a layer of tape was wound, then the primary consisting of 300 turns of No. 16 wire, in two layers over the entire ring, with tape between these layers as before.

The switch, K″, allowed the magnetising current to be sent either through the primary circuit of A″, or through the primary of the air-core standardising induction coil, C, which was made to obviate the use of an earth inductor for standardising the galvanometer and the consequent liability to error due to an inaccurate value of the horizontal component of the earth's field.

The ballistic circuit included the secondary, h, of the iron ring; the secondary, h', of the standardising induction coil, and the galvanometer, G, all in series, thus giving a constant resistance in this circuit during a set of observations, and simplifying the calculations thereby. The galvanometer was also provided with a shunt, R′, to regulate its sensitiveness, and the ordinary circuit arrangement for bringing the needle to rest between the readings, which is not shown in the diagram. The use of the standardising coil made the measurement of the magnetic induction as well as the magnetising force depend upon the *same* instrument, the Weston standard ammeter, and at the same time permitted, by the large number of turns it contained, inductions being reached sufficient to give ballistic deflections of the same order of magnitude as those given by the ring under test.

The standardising coil was wound upon a wooden rod of sufficient length to insure uniformity at its centre, and large enough to permit its sectional area being accurately determined, while the secondary coil was wound about the middle part of the primary coil.

First, the constants of the standardising coil and of the test ring were accurately determined; and then the magnetisation curves were taken. For this latter purpose the "reversal" method was used in the following manner:—

The magnetising current being commenced at its maximum value and reversed several times to bring the magnetisation up to its full extent, the ballistic circuit being open during

this preliminary operation, the secondary circuit was then closed and the current reversed, while the double induction was measured by the galvanometer throw. The current being then slightly reduced and reversed several times as before, the induction was again measured on reversing the current. By continuing this process until the magnetising current was gradually reduced to zero, data was obtained for plotting the curve. The reversal method has the great advantage that each point is determined *independently* of all the others, and as the final reading taken for a point was the mean of three taken for that point, the error is reduced to a minimum. The disadvantage of the step-by-step method is that each point determined depends upon the accuracy of each of the preceding points, and but one observation can be taken for a single point, besides the sample has to be thoroughly demagnetised before beginning, which is a difficult thing to accomplish, even with a powerful alternating current source at hand.

The two methods give curves of substantially the same character, except that the induction values are slightly higher by the reversal method. On account of the enormous vibrations which gun steel is subjected to during firing, the reversal method probably gives values too low instead of too high, which is an additional reason for employing this method.

A number of sets of observations were taken in this manner, and curves plotted which exhibit an exceedingly interesting character, and from which the magnetic permeability and reductivity can be obtained.

A number of magnetic cycles were also measured to determine the behaviour of gun-steel under cyclic magnetising forces. Here the "step-by-step" method was resorted to, and the cycle started in each case from its maximum induction in the following manner:—The limits of induction for the particular cycle being decided upon, the magnetising current was reversed many times as in the "reversal" method already described, to bring the magnetisation to its full value, then the magnetising current remaining unbroken, successively small resistances were introduced in its circuit, and the corresponding "throws" measured. When the magnetising current was reduced to zero in this way, the switch was reversed and the current successively increased in the negative direction until its value became equal to the positive force corresponding to the initial point. The induction corresponding to the initial point was taken from one of the curves. The galvanometer was used unshunted. On these lines the hysteresis constant for gun steel was obtained, and shown to be 0·007844. In the original paper a curve is given which shows the hysteretic cycle for gun steel.

Although the formula by which this value, 0·007844, is obtained (Steinmetz's Law of Hysteresis) has been recently shown by Prof. Ewing to be an empirical one, possessing no physical significance, it is nevertheless very serviceable, especially in cases involving alternating currents, such as in transformer design, since it gives close approximations over the range usually employed in practice.

Although Lieut. Squier only claims that these tests are superficial, they indicate, as is clear from the curves with which his paper is illustrated, that the steel, now being used in making the U.S. artillery, besides possessing remarkable physical qualities, also has excellent magnetic qualities, and might be used for the construction of electrical machinery with very efficient results. Compared with the average steel castings from various manufacturers in the United States, the magnetic values are 8 per cent. in favour of gun steel. The experiments indicate an improvement produced by forging as compared with simple steel castings, and further show that for marine dynamos and in gun-training motors, where space is valuable, steel of high permeability will, probably, be exclusively used in the future.

From data which have but recently come to hand, it would appear that there is a connection between the magnetic qualities and the physical conditions of steel, which is indicated by a combination of high physical qualities, *e.g.*, nickel-steel possessing in an unusual degree a combination of high elastic limit and ductility, is also found to possess exceptional magnetic permeability. This fact assumes a commercial as well as a military interest, since chrome-steel and nickel steel are just now attracting much attention as metals for the construction of cannon.

THE NICLAUSSE WATER TUBE BOILER.

The Niclausse boiler is one of the numerous crop of water tube boilers that have been put upon the market within recent years, and it has been taken up by Messrs. Willans and Robinson in this country, and made the subject of a lengthy paper before the Institute of Naval Architects by Mr. Robinson. Briefly, this boiler is one in which the water tubes are (*a*) inclined at a very flat angle of only 6°; (*b*) are attached at one end only to a water leg projecting downwards from the overhead drum, and having the rear and lower end of the tubes closed by a screwed cap, and merely supported so that the front water leg or header is not strained by the weight of the tubes; and (*c*) inside the tubes are smaller tubes extending from a division of the water leg to nearly the lower end of the outer tubes—Field tubes, in fact, whose duty it is to pass water from the bottom of the drum to the rear end of the tubes which deliver it in a more or less vaporous state to the drum at a higher level than that of the opening to the field tube section of the water leg.

It is claimed that the tests of the boiler made by Profs. Unwin and Kennedy show an evaporation from and at 212° of 10½ lbs., while the tests of Messrs. Willans and Robinson themselves show even 11 lbs. per pound of coal, which was but 95 per cent. combustible, and stated to contain only 13,860 thermal units. Practically there is "no priming" recorded by the salt test, but we do not care to place much reliance on the figures given in the absence of further information as to the means taken to measure the priming. Only 1 per cent. is shown by calorimeter, and we don't care to rely on this test, and since these tests were made in April, 1894, Prof. Unwin himself, unless our ears deceived us, stated, in our hearing, his disbelief, not in the calorimeter instrument itself, but in the means employed to gather samples of steam for the calorimeter. We are not told that the mode of collecting such sample would now receive Prof. Unwin's approval, nor are we informed that Prof. Kennedy's faith in the salt test is still strong as of old. For ourselves, we hesitate to accept any such figures from any water tube boiler, and say this entirely without any prejudice against the Niclausse boiler in particular, which, indeed, has points in its construction that seem to give it a good prospect of durability. But, in competition with the ordinary marine boiler, this country is making a very costly experiment with the Belleville type of boiler in our new cruisers, an experiment, the extent of which is entirely unwarranted by any information as to the performances of water-tube boilers, indeed as to which quite a number of figures have recently been forthcoming, which by no means tend to assure those whose one desire, whether they be Radical or Tory, is, that the naval position of this country should be assured, and not made the shuttlecock of a huge experimentation. So far as the various tests made with the Niclausse boiler show, the circulation is probably well assured by the Field tubes, as we should expect. The weight of the boilers in the French cruiser *Friant* comes out as ·33 ton per square foot of grate surface, including the water contents. In this cruiser the outer tubes are 3·22 inches external diameter, and there are 216 tubes in the 12 sections of each of the four larger boilers, the tubes being 7 feet 4½ inches long, and the grate 6 feet 6½ inches long, with an area of 45·75 square feet, the total heating surface being 1,340 feet.

Including the 16 smaller boilers with 10 sections each, the total grate surface is 775 feet, and the heating surface 23,200 feet. The horse-power obtained was 9,438 at full power, burning 25 lbs. of coal per foot of grate. The heating surface is thus about half as efficient in terms of engine power as that of a locomotive. The feed of the Niclausse boiler is admitted to an inner trough placed in the steam drum, and trials at Thames Ditton seemed to show that this had considerable effect in retaining deposit, and so preserving the outer tubes from incrustation, as indeed should be anticipated. Indeed, the wonder is that this device—so old—has not been more adopted.

The results are interesting so far as they go, but the paper is a special pleading for this particular form of boiler, and as such may lose some of the value that might otherwise attach to it.

CORRESPONDENCE.

Secondary Batteries.

Referring to Mr. Allingham's letter in your current number, allow me to state :—

1. That I have not yet seen an I.E.S. plate three times as thick as an E.P.S. one.

2. That the plates of which I gave comparative results in my paper were exactly the same thickness as an E.P.S. plate.

3. Comparisons were only drawn by me with that type of plate, as I consider it the best known, and hitherto most used in the market, and any electrical engineer would, therefore, be able to make his own comparisons with the other existing types.

4. The celluloid envelopes have sufficient elasticity to allow for the changes of volume, and yet to always fit plates closely.

I do not realise the difficulty which you appear to consider probable in your note contained in the same issue, but shall be only too pleased to see what the representatives of other accumulators may have to say in the matter. In the meantime, and until they have said all they may care to say, pressure of business forbids me from entering into any prolonged correspondence on the subject. I shall, however, be pleased to give a final reply, if required.

Anthony G. New.

August 6th, 1895

Lighting the Thames Embankment.

You are doing a public service in advocating the use of electric tramcars on the Thames Embankment, and if the admirable photo of posts supporting trolley wires and arc lamps, as shown in last week's Electrical Review, is not sufficiently convincing, a few real posts of the right height might be lent to fix in the middle of the roadway to show the effect.

There is only one way of lighting the Embankment, and that is as you suggest, by powerful arc lamps fixed on posts in the centre of the roadway.

A central station erected to supply current for arc lamps and power for electric tramcars could be worked at a proportionately smaller cost than if used for electric lighting only.

The profits derived from the working of the electric tramcars would go a long way towards reducing the cost of lighting the Embankment (as it ought to be lighted), and the combination would certainly add to its public use and popularity, and materially assist in reducing the daily congested traffic of Fleet Street and the Strand.

A. L. Fyfe.

August 6th, 1895.

LEGAL.

Wandsworth District Board of Works *v.* County of London and Brush Provincial Electric Light Company, Limited.

Judgment for the Company.

On Saturday, Mr. Justice Stirling, in the Chancery Division of the High Courts, gave judgment upon the motion in the action by the Wandsworth District Board of Works for an injunction to restrain the County of London and Brush Provincial Electric Light Company from excavating for and constructing or placing under the highways vested in the Board transforming or converting chambers, as reported in our last issue. The motion asked for interim injunction pending the trial of the action.

His Lordship said that the motion was one which sought to restrain the defendants from making these chambers, not being "street boxes" as authorised by Clause 12 of the Act of 1892, under which the company were acting, and from using any boxes constructed by them under the powers of the Act for the purpose of transforming electric energy, and the question he had to decide was one of construction of the provisional order, which had all the efficacy of an Act of Parliament. Clause 9 of the order provided that, subject to the provisions that it contained, the undertakers might supply electrical energy for lighting the district by electricity, and such energy was to be supplied by means of such a system as might be approved by the Board of Trade, and subject to such regulations as were necessary for the safety of the public and so forth. Section 11 conferred power on the undertakers, in order to enable them to execute the works, to break open streets, and lift rails and tramways and so forth. Clause 12 was that on which the question turned. It authorised the undertakers to construct in the streets certain boxes called "street boxes," and Section 13 required that notice should be given of any works that interfered with the streets or bridges to the Postmaster-General, the Local Authority, and the County Council, who had power to say whether they approved, and, if they refused, the undertakers might appeal to the Board of Trade, who might approve, or sanction, or allow the works to proceed. It was obvious that great powers were invested in the Board of Trade; first of all the system which was to be used was to be one which had met with the approval of the Board of Trade, and the system so approved was only to be used subject to such regulations and conditions for securing the safety of the public and a sufficient and proper supply of electrical energy as the Board of Trade might approve. Moreover, where streets were to be interfered with, the undertakers were to supply full and sufficient information as to the interference, and that information had to be given to three bodies interested in protecting the rights of the public—the Postmaster-General, the Local Authority, and the County Council. If they disapproved there was the appeal to the Board of Trade who might decide on any questions that might arise. The Board of Trade therefore had the function of adjudicating upon all matters which arose within the four corners of the order, as between the undertakers on one hand and the authorities on the other. All that procedure had been gone through in the present instance. The Board of Trade had prescribed and specified the nature of the system which was to be used. The converting stations were to be street boxes of sufficient size for converting the electrical energy according to the plans of the defendant company. What were here termed street boxes intended to be used for the purpose set forth in the Act might be described as receptacles made of iron of which the dimensions were 10 feet depth, 7½ feet length, and 5½ feet breadth, and they were to be used for the purpose of containing the transformers which change the electricity coming at a high pressure into electricity at low pressure. The objection on behalf of the Local Board of Works was that the Board of Trade in giving sanction to the use of these receptacles had authorised something which, according to the terms of the order, the defendants were not entitled to do. That turned on the true construction of the 12th Clause. The marginal note to that was "street boxes," and the clause itself provided that the undertakers might construct in any street such boxes as might be necessary for the supply of the proper energy, including the supply of ventilation and so forth, and the undertakers might place therein meters, switches, and other suitable and proper apparatus for the above purposes. The motion raised two points: first it was said that the receptacles which he had described were not "boxes" within the meaning of the Section, and, secondly, that the use of them for the purpose of transforming electrical energy was not authorised by the Section. These two points appeared to his Lordship to be independent, and they had to be decided separately. Were these receptacles "boxes" within the meaning of the Act? He assumed that the boxes which at the time the Order was made were in common use for the supply of energy for electric lighting were of much smaller dimensions than those used in this case; but there was nothing in the Act as to the size of the boxes, and it seemed to him that the question of size was one entirely within the province of the Board of Trade upon appeal being made to them either by the Local Authority, the Postmaster-General, or the County Council, to adjudicate upon them. Suppose, for example, that the boxes heretofore used were used for the purpose of containing meters, and that each box had contained a single meter at certain distances, and suppose that in the development of electric lighting it had been found desirable to group meters and to put a few at one spot instead of one for each single area, it was clear that meters were things which might be put in the street boxes, and he saw nothing in the Act to prevent the box being enlarged to such an extent that it might contain a greater number of meters than one—it might be twenty of them. The limit to which boxes might be placed in the streets appeared to him to be a question entirely for the Board of Trade to adjudicate upon under Section 13. The objection put forward as to the large size of these boxes was that they occupied a larger portion of street and interfered with the use of the street for the purposes for which it was ordinarily used, and for water and gas. But that was precisely a matter which it seemed to him the Board of Trade might properly adjudicate upon and say what in the interests of the public ought to be allowed in regard to the size of the boxes. It was also said that these boxes were really chambers. The question was—was it fair to describe these receptacles as boxes. It seemed to him that they were iron boxes. No doubt they were large boxes, but still they might fairly be described as boxes, and if the Board of Trade considered that they might fairly be used of that particular size to supply the public with electric energy, and were of opinion that they did not interfere with the use of the streets for other purposes, he did not think that the Board of Trade had gone beyond their powers in sanctioning the use of those boxes. The second question was whether the boxes might be used for the purpose of containing transformers to convert high pressure electricity into low pressure electricity. The uses which were to be made of the boxes were defined in the latter part of the 12th Clause, and so far as material, the words were that they were for the purpose of examining, testing, regulating and controlling the supply of energy, and the undertakers were at liberty to place therein meters, switches, or other suitable apparatus for the purpose. It was said that none of the words used in the clause described the function to which the transformers were appropriate. On the other hand it was said on behalf of the company that transformers were apparatus for regulating or controlling the supply of energy. These transformers

were large pieces of iron round which were coiled two sets of wires, the one for conveying electricity at high pressure, the other for conveying electricity at low pressure. The effect of the transformer was to diminish in a certain ratio—which depended on the size of the piece of iron, the number of the coils, and the dimensions of the wire—the pressure; so that if electricity came along at a high pressure and entered the transformer at the high pressure, on leaving it the pressure was reduced to a certain fixed ratio which was constant and the same for each transformer. It was said that that was not an instrument for regulating the supply of energy. The dictionary meaning of regulating was "to adjust according to rule or method." If, then, electricity entered the transformer at a particular high pressure, and, leaving it, was always reduced to a definite fraction of what it entered, it seemed to him that the supply of energy was thus "adjusted according to rule." But it was said that that transformer did not secure regularity in this sense, that if there were irregularities in the pressure of the current as it entered, there would always be irregularities, though on a smaller scale, in the current as it left. It might be that the current was not made perfectly uniform, but it might be regular without being uniform, and might pass according to a particular law without being absolutely uniform; and it seemed to him that this particular apparatus did adjust the pressure of electricity according to a definite rule, and was, therefore, a regulating machine in the sense which he had described. Did it control the supply? The meaning of the word "control" was "to hold in check;" and the result of these transformers was that the pressure was always reduced in a fixed proportion and was thus "held in check." His Lordship could not see that the Board of Trade had exceeded its powers, and he held that what was proposed to be done was within the Act and that the motion must be refused with costs.

Parties having agreed to take the hearing of the motion as the trial of the action, the action was thereupon dismissed, with costs.

Shelfer *v.* The City of London Electric Lighting Company, Limited.

On the appeal in this action being again mentioned on Wednesday, before Lords Justices Lindley, Lopes and Rigby,

Mr. Moulton, Q.C., said an affidavit had been filed by Mr. Frank Bailey, in which he stated that three out of the four engines in the company's works had been removed, and the escape of steam had been dealt with effectively. The evidence on the affidavits was very conflicting, and in mercy to the parties he hoped the Court would see its way clear to appoint an independent expert to report to the Court and suggest what ought to be done. He did not believe that their Lordships would ever be able to ascertain the exact facts from the affidavits.

Lord Justice Lindley: We cannot do that now.

Mr. Warmington, Q.C.: Something has been done by the company, but we are still suffering from vibration. I suggest that the company should be put on short terms.

After a discussion, the order was extended until the second motion day in the Michaelmas sittings, liberty being given to the defendant company to inspect the "Waterman's Arms," Southwark, from time to time.

Lord Justice Lindley: I must warn you Mr. Moulton that this extension of time cannot go on for ever.

Bankruptcy.

The application of Johnathan Lewis Young, dealer in phonographs, formerly carrying on business at 52, Fore Street, E.C., was again before Mr. Registrar Linklater at last Tuesday's sitting of the London Bankruptcy Court. The Bankrupt applied last June for an order of discharge from his bankruptcy proceedings, but it appearing that a motion was then pending in the High Court to set aside a transfer of the debtors business to a limited company the application was ordered to stand over until the present sitting. The particulars of the failure appeared in our issue of June 28th, and it will be remembered that the bankrupt failed last February with ranking liabilitiss £2,958 17s. 10d., and no available assets. The only offence alleged by the Official Receiver was that the assets were not equal in value to 10s. in the £ on the unsecured indebtedness.

Mr. E. Cooper Willis, Q.C., now appeared for the bankrupt in support of the application, and his Honour granted an order of discharge subject to a suspension of three years dating from June 25th, when the application was first before the Court.

BUSINESS NOTICES, &c.

Admiralty Contracts.—The United Asbestos Company, Limited, of Dock House, Billiter Street, London, E.C., have been awarded the contract for the supply to the Admiralty of asbestos packing and other goods for the ensuing year, 1895-6.

Alleged Stealing of Mercury.—Arthur Took, an assistant linesman, has been committed for trial on a charge of stealing mercury from the telegraph stores of the Great Eastern Railway.

A Worthy Example.—A return ticket on the South London Railway is now usable at any time.

Country House Lighting.—Stapeley House, together with the stables and out-buildings, is to be lit throughout with electric light. A Cornish multitubular boiler of 14 H.P. will drive a No. 6 "Parker" dynamo to charge 53 of the D.P. Company's latest type cells. The contractors are Messrs. Drake & Gorham, of 66, Victoria Street, Westminster, S.W.

Dissolution of Partnership.—The partnership existing between Henry George Ellis and George Edward East, trading as the London Battery Company, was dissolved on July 27th, 1895.

Electrical Engineering in Russia.—It is stated that the St. Petersburg branch of Messrs. Siemens are about to start works in Odessa, with the view of opening up trade in South Russia.

Exhibition at Leipzig.—A large Saxon Thuringian Industrial Exhibition is to be held at Leipzig from April to September, 1897. The Exhibition will comprise no less than 20 sections, including one devoted to electricity and electrical engineering.

Free Library Lighting.—Mr. Thomas Brown, of Birmingham, is to wire the Cardiff Free Library at a cost of £253 11s.

J. G. Statter.—We have received a circular from this gentleman which states that he has purchased the designs and goodwill, together with certain machinery and stock of the "Works Department" of Messrs. J. G. Statter & Co., Limited, and that he is now carrying on that business. Mr. Statter's business achievements need no comment from us, but we sincerely trust that they will not lightly be forgotten.

Junior Engineering Society.—We have received the *Record of Transactions* of this Society for the 13th Session, 1893 and 1894.

Lighting Salford School.—Messrs. Verity have secured the tender for fitting up Salford Schools for electric lighting, electric bells, &c.

North Country Work.—Messrs. S. Dixon & Son, Leeds, are engaged in lighting the Grand Theatre, Leeds. They are also arranging at Melmerby Hall, Ripon, the residence of J. T. Pearson, Esq., a 7-H.P. Crossley's oil engine, with one set 53 L 11 accumulators and dynamo with 150 lights; at Mr. Helmsley's, Leeds, a complete installation of about 80 lights; at Trinity Church, Leeds, 100 lights, and at the Yorkshire Ladies' School of Education, Albion Street, Leeds.

Parsons v. British Steam Generator Company.—At the West Riding Assizes held this week, Mr. C. A. Parsons recovered £60 7s. 2d. from the British Steam Generator and Refuse Utilisation Company, of Halifax, for the hire of engine and generator.

Personal.—We are informed that Mr D. C. Weir, the late secretary, left the House-to-House Company's employ on April 29th last.

South African Notes.—The following notes appear in the current issue of the *British and South African Export Gazette*:—Plant.—Electrical pumps are to be installed at Knight's Witwatersrand Mine.

The whole of the electrical plant at the City and Suburban Mine has been supplied by the Electric Construction Company, Limited, Wolverhampton and London, through Messrs. Reunert and Lenz.

The same makers, through Mr. J. H. Davies, Johannesburg, have supplied three dynamos to the New Croesus Gold Mining Company.

The Capetown and Suburban Electric Lighting Syndicate, Limited, has placed an order for additional engine and dynamo power to the value of £7,000.

Messrs. Edlin & Stevenson, Capetown, have now fitted up seven of the suburban churches with the electric light.

The electrical lighting plant has now been obtained for the Wemmer Mine.

Two dynamos of the Electric Construction Company's make have been supplied for the lighting of the New Comet Mine.

Theatre Lighting.—Mr. George M. Pinkerton, of St. Luke's Road, Clapham, has just completed an installation of 200 16 C.P. and 4 arcs at the Tivoli of Varieties, Bristol.

The Electric Staff System.—The electric staff system has superseded the old hand staff at the Stewartstown and Coalisland stations of the Great Northern Railway Company of Ireland.

Too Much Oil.—The Edison-Swan Company were at the City Court last week fined 40s. for storing more petroleum than the Act allows.

The Electric Current.—The *Daily News* says: "Benzoline coming in contact with an electric current caused an outbreak of fire last week on the premises of Messrs. Mackey & Co., electric lamp manufacturers, Bermondsey." Our contemporary probably meant electric spark.

The D.P. Accumulator.—We understand that several novel developments have been made in these cells, and the makers believe that a plate has now been produced which will resist any amount of ill-treatment.

The Sunderland Engineer.—The Highway Committee have decided to recommend that Mr. Vesey Brown's salary be increased by £60, and that he be permitted to engage a premium apprentice. In consideration, Mr. Brown is to superintend all extensions.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—The pier is being fitted for the electric light.

Brighton.—We understand that extensive progress has been made with the laying of the electric light mains for the public lighting of the Marine Parade and the Northern Valley.

Cheltenham.—The increase in the applications for electric light has been so steady that Mr. Alderman Norman, at a meeting of the Town Council on Tuesday, announced that the committee had no alternative but to ask the Council to sanction an application for a further loan of £10,000.

Cork.—While approving of the principle of lighting the city by electricity, the Council are not going to take any immediate steps with regard to companies which are applying for provisional orders.

Durban.—The Corporation will be calling for tenders for electric lighting very shortly.

Edinburgh.—The electric light system was extended last week to Canongate and Hope Park.

Electric Lighting in France.—It is proposed to establish a central station at Fraisans (Jura). One has just been completed and put in operation at Pornic (Loire-Inférieure). Sunday, the 11th inst., is the last date for the receipt of tenders invited by the municipal authorities of Ille-sur-Tet (Pyrenees Orientales) for the concession for the electric lighting of the town.

Electric Lighting in Italy.—A central station is being established near Battaglia (Padua) by Messrs. Siemens & Halske, of Berlin.

Electric Lighting in Spain.—Not a single offer was received in response to the recent invitation for tenders for the concession for the electric lighting during a period of 20 years of the little town of Cullera, in the province of Valencia.

Gloucester.—Notice has been given by the Great Western Electric Light and Power Company of intention to apply for a provisional order.

Hampstead.—The Lighting Committee have been given powers to act in the matter of extensions. On June 22nd 18,000 8-C.P. lamps were connected to the mains, and it is estimated from the new applications that there will be 20,000 lamps on the mains by Christmas. As the present plant will only supply 12,000, it is recommended that a large unit be bought at once, at a cost of £2,325.

Hastings.—The Public Lighting Committee want to increase the lighting by two more arc lamps, but the local company will not undertake to light them for less than £40 per lamp per annum. Councillor Tuppenney, at a recent meeting of the Town Council, naively remarked that as the Electric Lighting Company lost money on the lighting of the front, they were going to recuperate (*sic*) themselves upon the two lamps.

Hospital Lighting.—The Governors of the Hospital for Consumption, Brompton, have decided to light the whole of their hospital premises by electricity.

Limerick.—The Corporation have decided to ask the Local Government Board to hold an inquiry with regard to a loan for electric lighting.

Nottingham.—The Castle, among other places, is to be lighted from the extensions.

Oswestry.—The Oswestry Light and Power Company will be in a position to furnish current in a day or two. The engines are now being laid down.

St. Helens and Electric Lighting.—At a meeting of the Electric Lighting Committee of the St. Helens Corporation, tenders were accepted, subject to the approval of the Local Government Board. The Committee instructed the Town Clerk to apply to the Local Government Board for sanction to borrow £10,000 for carrying out the works in question. A list of the successful tenderers will be found under Contracts Closed.

St. Pancras.—Mr. J. F. C. Snell has been appointed resident engineer to St. Pancras new station, and Mr. Burnett and Mr. Hooper have been selected as assistants.

Shoreditch.—Besides supplying the refuse destructor for the new station, Messrs. Manlove, Alliott & Co. will, at a cost of £2,683, erect the chimney shaft.

Wimbledon.—Mr. A. H. Preece's scheme has been adopted. A loan of £32,000 is to be applied for.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Auckland, New Zealand.—An English company is proposing to run electric tramways and supply electric light.

Electric Carriage in Philadelphia.—An electric carriage has been running with considerable success in the streets of Philadelphia since August, 1894. It was built to obtain data for driving electric carriages on ordinary roads.

Electric Lift.—The Brighton Town Hall is to be furnished with an electric lift.

Electric Mail Cars.—The electric cars in Boston are used for distributing the suburban mails.

Electric Traction in France.—The construction of electric tramways between Angers and Erigaé, and between Angers and Pyramidè (Maine et Loiré), has just been decided upon. The lines will be on the overhead conductor system. Several lines of electric tramway are also to be constructed in the town of Limages. The Lyons Omnibus and Tramways Company is considering the question of adopting electric traction on all its tramways. Plans have been prepared for an electric tramway between Rochefort and Tonnay-Charente (Charente Inferièure). It is proposed to construct an electric tramway between Tours and Luynes, and one between Tours and Saint Avertin (Indre et Loire).

Higher Speed Necessary.—The Brooklyn trolley cars are not travelling fast enough for the customers, and the authorities are being asked to increase the speed.

Launches in Ireland.—The building of an electric launch in Kingstown is attracting much attention. The launch is intended for harbour work.

Middlesborough.—The Town Council were to be asked on Tuesday to approve of the equipment of certain portions of the Hartlepool line with electricity.

Power-Driven Carriages.—A correspondent asks the following question in the *British and South African Export Gazette*:—"I should be glad to know whether there is any firm putting on the market a practicable and commercial vehicle which can be driven along ordinary roads by steam, electricity, or compressed air. If so, I shall be glad to receive prices and other details. I am told that such carriages are now being manufactured in France, but I should prefer, if possible, to have particulars from a British maker. I think there might be an opening for them out here, if they could stand our rough roads."

Rivals.—The St. Pancras Vestry have decided to refuse permission to the London Hydraulic Power Company to lay their pipes in the parish, on the ground that "the company must be regarded as competitors with the Vestry, inasmuch as the electricity department is prepared to supply the necessary power for the purpose required."

The Edinburgh Tramway Company and Electricity.—At the meeting of this company on Monday, the Chairman, in the course of his remarks, said the directors were by no means satisfied that cabling was the best system. Cabling was now being superseded by electricity in America, and that fact had to be borne in mind by the authorities who should decide as to the motor power to be employed in Edinburgh. There was no difficulty because of the gradient in Leith Walk, for electricity, as well as cables, had been employed with success on quite as heavy gradients. It was the best system that ought to be adopted, and that system, whatever it was, would be followed by the company without hesitation.

TELEGRAPH AND TELEPHONE NOTES.

A Long Span.—The telephone wire which crosses the Wallensee, in Switzerland, is said to have a span 7,850 feet long.

Cable Interruptions.—We are glad to say that for some time past the interruptions to cables (*i.e.* those which have been reported) are very few. From the speech of the chairman of the Anglo-American Telegraph Company we learn, however, that the Duxbury and the Newfoundland-Cape Breton cables are down, and as the repairing ship is engaged on these, the Brest-St. Pierre cable, which has been interrupted since April 6th, 1893, two years and four months ago, will be allowed to remain so for the present.

The Fastnet Rock Cable.—The *Illustrated London News* for last week published some charming little sketches illustrating the laying of the above telegraph cable, by Mr. L. Shafto Connell, of H.M. telegraph ship *Monarch*.

Telegraphs in Borneo.—About 90 miles of the telegraph across British North Borneo are now complete, and the entire length to Sandakan is expected to be in working order by January next.

The Relations between Geology and Cable Surveys.—In a paper by Major H. de Haga Haig, R.E., F.G.S., on "The Physical Features and Geology of Mauritius," recently read before the Geological Society, the author says:—"The northern part of the island—the pointed end of the pear—is cut off from the rest by these mountain walls, but the general direction of the watershed continues across it at a much lower level, and is even prolonged under water by a bank extending 14 or 15 miles before it sinks to 100 fathoms below the sea; the general depth of the sea-bottom around being about 1,800 fathoms. The five or six small islands to the north

are on this bank, which also rises in some places in the objectionable form of dangerous reefs, on which a furious surf is always breaking. There is also a bank (called 'l'Ilot aux Pintades'), extending from the south-western point of Mauritius (10 miles) towards Bourbon, which appears to be a continuation of the central ridge. In fact, Mauritius is on a line of weakness of the earth's surface, along which volcanic disturbances have taken place. This line passes through the volcanic islands of Rodriguez, Bourbon, and Madagascar. From soundings taken round Mauritius and Bourbon, in connection with a scheme for laying a submarine telegraph cable, it was found that between the two there was a level sandy plain at a depth of 1,800 fathoms, which extended all round Mauritius, except to the north, where, as one of the men employed on the work stated, 'It was like sounding over precipices; depths of 600 and 1,300 fathoms would often occur in close consecutive soundings.'"

Telephonic Communication between Denmark and Germany.—The international telephone line between Hamburg, Odense, and Copenhagen, is now completed, and is to be put in operation in a few days.

The Rise of Aestheticism.—The Alderley Edge District Council are protesting against the ugly telegraph poles in the neighbourhood.

The Islet of Trinidad as a Cable Station.—From a leading article in the *Times* of the 6th current, it appears that the Islet of Trinidad was re-occupied by H.M.S. *Barracouta* in January last, as a cable landing place, the idea being to cut Brazil out from the direct line of telegraph communication between Europe and the Argentine Republic. This would probably be done by running a cable from St. Vincent to the Island of Ascension, and from that place to the River Plate, using Trinidad as an intermediate station. It is not surprising that the Brazilian Government object to the proposed step. As to the suitability of the island for a landing place, the following extract from "The Cruise of the Alerte," taken together with the knowledge that the depths near the islet are very considerable (nearly 3,000 fathoms), goes to prove that this link will always be a weak one. In his book Mr. Knight says:—"This islet has been so shaken to its foundations by earthquake shocks and volcanic action, that it is brittle from its mountain tops to the beach, and is in a state of perpetual change; gigantic landslips are frequent," &c.

Our contemporary in speaking of the occupation of the above islet, gives the following as the reason:—"It has now become of some importance to us for a practical reason of a very simple kind. All English cables between South America and Europe have their western shore ends at Pernambuco. The result is that Brazil controls the whole of the direct telegraphic communication of the Continent with Europe, a state of things which is, for many reasons, undesirable. The distance between the countries south of Brazil and England is too great for a direct cable. Such cables, if they are not to pass through the continental territory of Brazil, must be laid to some half-way house in the Atlantic, and Trinidad appears just such a resting place as engineers require.

Telephonic Communication in the West Riding.—A large system of private telephones for police service has been adopted in the West Riding of Yorkshire.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aylesbury.—August 9th. For lighting the several public lamps and clock tower within the district for one year from September 1st, for the Aylesbury Local Board. The conditions for lighting and all other particulars in connection therewith may be obtained on application to Mr. George Fell, clerk, Aylesbury, to whom tenders must be sent by August 9th.

Cowes.—August 27th. Tenders are invited for laying down electric lighting plant of sufficient capacity to supply at the same time 2,200 8-C.P. lamps, also public lighting and the laying of mains to accommodate 3,000 lamps. Details can be obtained from Mr. N. F. Dennis, engineer to the Council, Cowes.

France.—August 11th. The Municipal Authorities of Ille-sur-Tet (Pyrénees Orientales) are inviting tenders for the concession for the electric lighting of the town. Tenders should be directed to the Mairie d'Ille-sur-Tet (Pyrénees Orientales), France.

France.—Tenders are being invited by the General Direction of the French Posts and Telegraphs, until the 8th inst., for the construction and fitting out of a principal telephone office in the Rue Chaudron, Paris. Tenders are to be sent to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Holland.—Tenders are being invited until the 21st inst. by the Dutch Minister of the Colonies for the supply of a large number of iron telegraph poles. Tenders to be addressed to the Technical Bureau, Ministry of the Colonies, The Hague.

Holland.—August 9th.—The Minister of the Waterstaat at the Hague, is inviting tenders for the construction of a new post and telegraph office in Amsterdam. Tenders to above.

Islington Municipal Offices.—Tenders are wanted for the wiring of the Vestry Hall and Municipal Offices, and for the supply of fittings. Tenders to be sent by August 27th. Further particulars may be obtained from our advertisements of "Official Notices."

Killarney Lunatic Asylum.—Tenders are wanted for wiring the Killarney District Lunatic Asylum; supply will be obtained from the high tension mains of the Killarney Electric Lighting Company. Tenders to be delivered by August 30th. Further particulars may be obtained from our advertisements of "Official Notices."

Portland.—The Urban District Council of Portland invite tenders for the lighting of the district of Portland, as under, with gas, oil, or electric light:—140 ordinary lamps: 16 Bray's lamps; 6 all night lamps; from September 1st to April 30th. Tenders to be delivered sealed, and marked "Tenders for public lighting," at the office of the Council, New Road, Portland, not later than Tuesday, August 13th, 1895.

Portsmouth.—For laying about seven miles of stoneware ducts for electric cables required for the extension of the Corporation system. Specifications can be obtained at the station, Gunwharf Road, and tenders, addressed to the Chairman of the Electric Lighting Committee, should be delivered there by 14th inst.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Spain.—The Municipal Authorities of Biar (Alicanté province) are at present inviting tenders for the concession for the electric lighting of the town during a period of five years. Tenders to the Secretaria del Ayuntamiento, Biar (Alicanté).

Surbiton.—Six firms are to be invited to send in plans and specifications for electric lighting.

Vienna.—The Municipality of Vienna ask for tenders and plans for the construction and working of electric railways in and around the city. Tenders must be sent in before November 14th next. The notice may be seen at the Commercial Department of the Foreign Office. For further particulars, see our advertisement pages.

Wakefield.—The Corporation Electric Lighting Committee invites tenders for the supply and erection of boilers, engines, alternators, switchboards, cables, transformers, arc lamps, &c., &c., for the intended electric lighting installation. For further particulars, see our advertisement pages.

Wellington (Salop).—The Shropshire Iron Company are inviting tenders for electric lighting plant, forges, &c., &c.

CLOSED.

Belfast.—The tenders of Messrs. Shaw & Co. for cast-iron. Doulton & Co. for insulators, the British Insulated Wire Company for copper strips, Messrs. Coates & Son, Castle Street. for road work, and the Callendars Bitumen Telegraph Company for cables, have been accepted for the extensions.

Cardiff Free Library.—The tender of Mr. Thomas Brown for wiring the Cardiff Free Library has been accepted by the Corporation. The amount was £253 11s.

St. Helen's.—The following tenders have been provisionally accepted:—Boiler house plant, Yates & Thom; engine house plant, Johnson & Phillips; switchboard, S. Z. de Ferranti; underground work, British Insulated Wire Company; transformers, John Fowler & Co.; meters, Chamberlain & Hookham; travelling crane, Carrick & Ritchie.

NOTES.

Test of the Niagara Electric System.—The *Scientific American* says the first practical demonstration of the system of transmission to be employed by the Cataract Construction Company in carrying the electric power to its customers took place June 29th. Two thousand horse-power was conveyed from the power-house to the works of the Pittsburg Reduction Company, a distance of three-quarters of a mile. Its course was first through the subway to the transformer building, where the alternating current, by passing through both static and rotary transformers, is changed to a direct current, then sent to the factory. The machinery worked smoothly, and the test was pronounced an entire success. Among those present were President Sellers, of the Niagara Falls Power Company; Chief Electrician Thompson, of the General Electric Company; Chief Engineer Breckenridge, of the Cataract Construction Company; Superintendent Emmett, of the General Electric Company; and the engineers of the General Electric Company who have been in charge of the work.

Unique Coal Cutting Plant.—The General Electric Company of America have adopted a novel and practical method of convincing coal owners of the economy to be effected by the use of coal cutting machinery. A large closed railway car, 40′ × 8′ × 9′ in height, is equipped with a complete plant for generating power, comprising a water-tube boiler, giving 40 nominal H.P. at 100 lbs. pressure, a high speed engine running at 300 revolutions per minute, cylinder 8½″ × 9″ stroke. The dynamo runs at 900 revolutions per minute, driven by belt, and gives a three-phase alternating current at 550 volts, being excited with a 1½ kilowatt continuous current generator. The capacity of the generator is 100 H.P., and it is rated to work five coal cutters. The equipment of this car is complete with switches, resistances, instruments, &c. The car can be taken over the railways into the sidings of any colliery and there put to work. The coal cutter carried by the same car, and put into the mine, has several interesting features. It is of the revolving chain cutter type, and is driven by a three-phase alternating current motor, which is completely closed in. The capacity of the motor is 20 H.P., but its normal rate of work is 7 H.P. It is claimed to be an advantage incident to the use of this three-phase motor, that in the event of its being overloaded it will pull up, thus saving the possible risk of breakage on the machine. This is, however, a questionable advantage, for one great feature in electric over compressed air coal cutters, is that they do not pull up because they are for a short time overloaded. It is also to be noted that in order to meet with overloading, a 20 H.P. motor is put in to do 7 H.P. Owing to the fact that at low loads the "plant efficiency" of three-phase motors is very low, this must mean considerable loss of economy in cables and dynamo and motor. Thus, taking a motor working as this one is at about one-third its full working load, the apparent watts put in will be about half of the full load in-put, so that the plant efficiency is only about 66 per cent. of the full load plant efficiency, and taking this at most at 90 per cent., the plant efficiency at the working load will come to 59·4, say, 60 per cent. Putting this point aside, however, the whole plant seems well designed, and if the performance claimed, viz., 130 square yards undercut in 10 hours, means the regular output of the machine taking an average of several months' work, it is a very good one, and the General Electric Company deserve every credit for their spirited endeavour to convince a class of buyers, who in this country at least, are very slow to learn.

Method of Measuring Electric Capacities.—Mr. H. Bordier, in a paper read before the Académie des Sciences, describes a method of measuring electrical capacities, based upon an experiment by Prof. D'Arsonval. If condensers of increasing capacity are placed successively in series on the same induction coil, and if, either by the aid of a rheostat or by moving the coil by predetermined steps, the moment is found determined in which the least sensation produced by the current on the skin is perceived, it is found that this moment varies for each added capacity. With a microfarad divided into tenths, it is stated to be easy to find two positions either of the rheostat or of the coil which correspond to the initial sensations produced by each tenth of microfarad added. The method allows a very approximate measurement of the capacity of the body of man to be obtained. The results showed:—First experiment, 0·002 microfarad; second experiment, 0·003 microfarad; average value, 0·0025 microfarad. This capacity is about 58 times greater than that of a homogeneous conductor, the surface of which would be equal to that of the human body. It is suggested that this capacity, relatively large, of the human body is due to phenomena of condensation occurring in the heart of the organism.

Electric Traction in Paris.—Messrs. Baillet and Grosnier have recently submitted to the Municipal Council of Paris a project for an overhead tramway worked by electricity and constructed at the height of the first floor of the houses. The Municipal Council has forwarded the proposal to the Government, requesting that a place should be appointed where a trial of this system can be made. We shall, therefore, hope soon to hear of an interesting series of experiments in electric traction in Paris.

Croydon County Polytechnic.—The committee have appointed Mr. H. B. Ransom, A.M.I.C.E., to be lecturer in charge of the Mechanical Engineering Department at the Croydon County Polytechnic. Mr. Ransom has been asked to organise a complete curriculum for professional students of mechanical engineering and to prepare plans and arrange for the establishment of a Mechanical Engineering Laboratory. The courses of lectures will include, (*a*) Materials of construction; (*b*) Structures and machines; (*c*) Prime-movers and thermo-dynamics. The laboratory course will deal with testing of materials, graphic statics, and the graphical calculus, &c. At first only two lecture courses will be taken. The Electrical Engineering Department will include a lecture course covering the ordinary grade of telegraphy and telephony, and the honours requirements in telegraphy; a preliminary lecture course for beginners in electrical engineering, and a workshop course preparing for the new practical "wireman's" examination; a lecture course covering the subjects of the ordinary grade in electrical engineering, and a lecture course dealing with the requirements of section *a* of the honours grade, electrical engineering. A laboratory course will be held for research work and to give practical experience in the matters included in the honours lecture course. To this only qualified students will be admitted. Mr. H. L. Mills, the silver medallist of the year in the ordinary grade of electric lighting, has been appointed assistant lecturer and laboratory demonstrator in the Electrical Engineering Department. The complete courses in mechanical and electrical engineering will provide a useful preliminary training for students intending to enter either of these professions, and no effort is being spared on the part of the committee or by its two most interested members, Mr. J. W. Helps, A.M.I.C.E., and Mr. T. Cushing, M.I.E.E., to raise the standard of technical education in these and other departments. This institution has the great advantage of the advice of these gentlemen, the one a practical engineer and the other a well-known electrical engineer; the benefits derived can only be properly estimated by those who like ourselves have been brought into contact with them and the work done at the County Polytechnic.

Action of the Soil on Iron Poles, Pipes and Cedar Poles.—The *Annual* of the Engineering Society of the University of Michigan, gives some interesting information relative to the rusting of iron poles and the rotting of wooden ones. Experiments with ordinary 4-inch gas pipe used as trolley poles, and set in concrete up to the surface of the ground, without other coating, developed that they would become corroded through at about 10 inches below the surface in about three years, forming a black deposit. The life of white cedar poles in the clay soil of Detroit is said to be about 13 years, without protection or treatment of the butts. Norway pine poles have lasted in the same soil about 30 years, but were badly rotted at the surface line. They, however, rot very soon in a sandy soil. The more pitchy ones decay first. Winter cut poles and those cut in summer with the sapwood removed are more lasting than those containing green sapwood. It is reported that steam piping, covered with a non-conductor, and maintained at a temperature from 250° to 300° Fahrenheit, though buried in the ground, will not corrode, while a hot water return at 212° Fahrenheit, similarly covered and buried, would corrode from the outside by rusting.

The Société Internationale des Electriciens.—The last sitting of the season of the Société took place on July 3rd. In the absence of M. Potier, Dr. D'Arsonval presided. M. Hillairet is appointed as delegate to the Congress for the Advancement of Science. The electrical laboratory has received a gift of four Julien accumulators of 175 kilogrammes. M. Gosselin performed an experiment, which consisted of melting, by effecting communication between the positive pole and an electrode placed at the bottom of a bath of carbonate of soda, and connecting the negative pole with a metal rod which is brought near the solution. He then collected the melted globules, which were hollow and contained hydrogen. This experiment is an old one, and was M. Planté's idea. Dr. Tripier then explained in detail the principal operations in use in electro-therapeutics, and the sitting terminated. It was very poorly attended.

How Electricity Sets Fire.—William McDevitt, Chief of the Electrical Department of the Philadelphia Underwriters' Association, recently gave a demonstration of some of the ways in which fires may be caused by electricity. The first danger was that arising from the common practice of grounding telephone wires on gas pipe. A bad connection is generally made—quite sufficient for telephone purposes—and then if the telephone wire becomes crossed with an electric light wire, the larger current meeting resistance at the ground connection heats the joint, punches a hole in the gas pipe, and the arc formed lights the gas. Mr. McDevitt gave a complete demonstration of the gas and insulation on the wire burning simultaneously. He also exhibited a section of gas pipe that had caused a fire in just this way :—The wires in the sockets of electric lamps are liable to touch the casing, when an arc may be formed. For this reason, no drapery should be used around the lamp sockets. The advantage of using metal conduits with insulated lining through which to run the wire was demonstrated, a wire outside being dangerously heated, while from that inside the conduit there was no risk. A caution was given against the rough handling of flexible cords used for electric lights as a common cause of short circuits and fire. There are other dangers due to ignorance on the part of the general public of the character of the electric current. In one case on record, the walls of a room were upholstered with stuff in which were interwoven a great number of metal threads. These were in contact with the electric light wires, and when the current was turned on, the whole room was set ablaze. An obscure danger from frictional electricity has been traced. Sparks may be caused by shuffling the feet on carpet or by the rubbing of silk. Where benzine is used to clean such materials, a spark thus caused may give rise to a dangerous fire. It is believed that some benzine fires have been caused in this way. Another cause of fires is the unreliability of fuses. They are put in the line to be burned out when an excessive current is turned on, but, like safety valves, they do not always work. If they fail to fuse, a dangerous current may be carried along the line. To obviate this danger, a standard should be adopted.—*Boston Transcript.*

The Physiology of Death by Electric Shock.—The following letter appeared in the last issue of the *Lancet*:—

An annotation in the *Lancet* of July 27th attributes death in electric shock to "stoppage of the heart." It is useful to inquire how and why this stoppage occurs. Dr. A. M. Bleile (Ohio) has lately investigated the physiological events which, in his opinion, lead up to it. Experimenting upon dogs with strong currents of stated strength, he finds, on examining the heart immediately after death, that "the left side is completely relaxed, and the right side intensely gorged with blood, as are also the large veins in the immediate vicinity of the heart. . . . . Incisions into the animal are not followed by bleeding, and the arteries are contracted down to a very small calibre." It was suggested, therefore, "that the current acted upon the arteries through the nervous centre which controls their diameter." To test this view, dilatation of the arteries and fall of blood pressure was effected by bringing the animal under the influence of nitrite of amyl. Under these circumstances a current of 0·24 ampères at 52 volts for three seconds (ordinarily a fatal dose) did not produce death. The conclusion arrived at is "that death in electric shock is really due to the fact that the current produces a contraction of the arteries through an influence on the nervous system, and that this constriction of the arteries throws in such a mechanical impediment to the flow of the blood as the heart is unable to overcome, and that where drugs are given to counteract this effect, much larger doses of electricity than the ordinary can be borne." The experimental data on which this opinion is based are given in such detail, that the experiments can be repeated, and results verified. The paper is a useful contribution to the physiology of death by electric shock. It may be incidentally mentioned, however, that the absolute amount of mechanical energy used, as measured in "joules," does not necessarily bear any direct relationship to the physiological effects of an electric current. In other words, a weak current for a long time is a very different thing from a strong current for a short time, although in each instance the "joules" may be the same.

I am, Sirs, yours faithfully,

W. S. Hedley.

Brighton, *July 30th*, 1895.

The last three lines of Dr. Hedley's letter might have been taken from our own note on this subject in the issue for July 26th, page 107.

The Latest American Railway Statistics.—The mileage of electric tramways in the United States now stands at 10,363.

The "Western Mail" Search Light.—When we reflect upon the wealth of language that the newspaper reporter can bestow upon an electric search light, we feel that there must be something cramping and enervating in technical journalism, for at our best we never thought to reach the heights which the Cardiff scribe has attained in a recent issue of the *Western Mail*. It appears, at least as far as we can judge from the following, that the *Western Mail* has got a search light, and the reporter has been looking at it, for he says :—

A hundred feet above the street upon the summit of the *Western Mail* tower! Around is blackness; below the lights of the street twinkle and flicker, looking like distant fairy lamps. Venus and Saturn have just limned themselves against the mass of clouds, and one or two struggling stars peer out of the heavy shadow with just strength enough to reveal the darkness. Click! The current is on, and a 16,000-candle-power glare belches forth, cutting a pathway of light through the inky darkness. The operator takes possession of the cylinder and swivels it about, sweeping the sky with a besom of brilliancy. What a panorama passes before us as we suit our actions to the swivel and follow the direction of the light. A church steeple suddenly rushes into view, every line of architecture standing out in relief; a degree or two more to the south, and there are tall chimneys and the masts of ships. Away still further, as we follow the light, the Channel coast passes in review, cut off, presently, by Penarth's Cliffs, only to be succeeded by the hills and dales of the Vale of Glamorgan. Now horizontally, now vertically, the bright ray travels, anon shining up into the heavens as if proclaiming a challenge to the whole firmamental galaxy, and then swooping down upon the busy streets, startling pedestrians, bewildering horses, and illuminating, like a beam of mid-day sun, the upturned faces of the crowds waiting and watching for election results. So much for the little vagaries of the *Western Mail* search light, which for thirty nights has looked down, a single but bright-eyed detective, upon the nightly doings of Cardiff.

Had we such a "besom of brilliancy" in our writing we could "swivel" our readers up to the "firmamental galaxy," whatever that may be, and then swoop them down upon the busy streets, and no doubt improve our circulation as well as theirs.

Charging Accumulators from Alternating Currents.—A recent paper by Mr. Pollak is abstracted briefly in the *Elek. Zeit.*, June 20th. He considers that alternating currents alone are suitable for transmission for great distances, and he therefore emphasises the importance of being able to convert alternating into direct currents; this may be done by means of his rectifier, which has already been described, and which he suggests placing at the distant end of a line for charging accumulators; in this rectifier only a portion of the wave of current can be used, being limited to that during which the voltage is greater than that of the accumulators; the regulation of the exact point is accomplished by moving the brushes; the efficiency of the rectifier is stated to be 96 to 94 per cent. He states that such a current has the peculiar property of accelerating electrolytic processes, a property which has not yet been explained.—"Digest," *Electrical World.*

Storage Batteries for Telegraph Work.—The *Western Electrician*, of a recent date, gives some statistics relative to the advantage of using storage batteries for telegraph work, in the place of primary batteries. The cost of maintenance of primary batteries per cell per annum is stated to average about $1.37, an amount which, we believe, is about five times that at which the cost of batteries in the English Postal Telegraph Department is found to work out, this being 1s. for the Fuller bichromate, and 9d. for the Daniell. For main line work the current required is said to be 40 milliampères per relay, and for local work from five to eight times that amount. The great advantages found in the use of storage cells are the small space required and the low cost of charging, which may be taken at 9 cents per cell per annum, which, with depreciation, &c., makes a total of 14 cents, against $1.37 for primary cells. Chloride accumulators are preferred for the purpose.

Three-Phase Railway System.—The *Street Railway Journal* says that the first application of the three-phase long distance system for railway work will be made at Lowell, Mass., by the General Electric Company. A low voltage alternating current will be raised to 5,000 volts, and carried to two sub-stations 9 and 14 miles distant, it will be then sent from rotary converters on to the line at 500 volts.

The Falls of Foyers.—Dr. Andrew Common has replied most effectually to the criticisms of the champions of Scottish scenery. On the occasion of a visit of the Inverness Field Club to Foyers, he said that all the necessary elements for the cheap production of aluminium had been found in the United Kingdom. Bauxite, the raw material, is extensively found in the mines in the North of Ireland. It will be treated in the company's factory at Larne by a simple chemical process, by which the alumina will be extracted. This alumina will be brought to the factory at Foyers and there subjected to the electrolytic treatment by which the pure aluminium will be separated from the oxygen, the latter going away in the air. The pure aluminium will then be collected in the form of ingots and shipped from Foyers to the industrial centres. No solid *débris* of any kind will result from the process under which the company will work. The cost of manufacturing aluminium by steam-power would be about £20 per horse-power per ton, whereas at Foyers the cost of manufacture by water-power would be £4 or £5 per horse-power per ton. It was that difference that brought the company to Foyers, which they have purchased. He referred to the many uses of aluminium, dwelling upon its great value as an alloy. The damage by their operations to the scenery, Dr. Common assured the visitors, will be absolutely *nil*. From the utilitarian point of view, the opposition to the company, as expressed in the Duke of Westminster's letter to the papers, was absurd. The forces of nature, such as these falls, should be used for the benefit of mankind, as they were all over the world. Even if there was a little damage to the beauties of nature, that must be put up with. It would be the object of the company to do as little damage to the surroundings as possible. Nothing would destroy the natural beauty of that glen. The fact of a little water coming down through it or not was a mere detail. The beauty was in the surroundings. Provost Ross asked if there was any truth in the statement that the vegetation would be destroyed. Dr. Common said that, while a good deal of hydro-fluoric acid had been given off by the furnaces in the early days of the manufacture of aluminium, it was now absorbed and rendered absolutely innocuous. The remarks of the Duke of Westminster about spoil heaps were also quite baseless. Provost Ross said it was very gratifying to hear those assurances from Dr. Common, and the best thing they could do, in the interests of the Highlands, would be to wish the company all success.

Electric Lighting Examinations.—The City and Guilds of London Institute have introduced several modifications in the syllabus of the technological examinations in electric lighting and distribution of power during recent years, and a further alteration has now been notified. It will be remembered that a few years ago a preliminary examination was instituted, to which wiremen and others were expected to go up. It requires but the merest modicum of knowledge, and that of the most elementary kind, to enable a candidate to obtain a "pass," and the authorities very wisely considered that the questions were of such a simple nature that successful candidates were hardly entitled to any acknowledgment in the way of a certificate upon them. It is now notified that candidates who are wiremen may, after passing the preliminary examination, present themselves the same year for a practical examination in wiremen's work, for which a special certificate will be granted. This may have a good effect in raising the standard of work, and the only thing now wanted is an adequate supply of experienced and competent teachers. No doubt facilities will be given for workshop training by the principal London technical institutions.

Electric Traction from St. Denis to Pierrefitte.—We know that electric traction in the form of tramways driven by accumulators already exists on several lines between Paris and St. Denis. These lines are about to be extended as far as Pierrefitte to the junction of the Boulevard of the station with the Avenue du Nord. The Tramways Company of Paris and the Department of the Seine requires, in order to make this extension, an annuity of 2,500 francs, as a sinking fund for the capital necessary for the execution of the work. The Commune of Pierrefitte has offered 2,000 francs, and the General Council of the Seine will furnish the remainder.

The Supply of Electric Energy by a Private Individual.—"Bourgeois," to whom we replied last week, again asks:—"Does your answer apply in the case of a place of worship, church, or chapel; if so, where is the line drawn, and when does it become necessary to apply for a provisional order or license?" Our answer applies equally to places of worship. When our correspondent asks, however, where the line is drawn, we confess our inability to give him an adequate reply. It is possible for any company to supply electricity without a provisional order or license, but in the event of any complaint or grievance they would have no *locus standi*.

Electricity and Religion.—A morning paper says:—"The Sacred Congregation at Rome has arrived at an important decision. Consulted as to the installation of the telephone in a convent, it has replied that such an innovation might be allowed, but that it should only be used in grave circumstances. Further, communication should only be established in the presence of two sisters! The subject of introducing the electric light into churches has also been under the consideration of the Sacred Congregation, which has decided that though the electric light may be used in churches, only wax lights are *de rigueur* for the celebration of serious rites."

Electrical Installation on the Paris Boulevards.—An interesting electrical experiment was tried for a few nights on the occasion of July 14th in front of the Marguery Restaurant on the Paris Boulevards. An immense wheel, from 4 to 5 metres in diameter, designed by M. Champion, was erected for illuminating purposes. On it were arranged incandescence lamps of all colours, and it was made to revolve by an electric motor. During the rotation, special interrupters enabled different effects to be produced by successive extinctions. This new mode of illumination was a great success.

Electric Lighting on the Embankment.—The letter from Mr. Fyfe, which we publish in our "Correspondence" columns, is worthy of some consideration. No doubt there would be many difficulties raised by the County Council to working a combined scheme of lighting and traction; but Mr. Fyfe's suggestion would go a long way towards solving what has become apparently a difficult problem.

A Successful Company.—It is very gratifying to find the lay press speaking well of electrical companies. Some few days ago one of our lay contemporaries was sanguine that the next dividend of the City Electric Lighting Company would be at least 10 per cent. This is not by any means a prophecy, and this in spite of huge mistakes of which the company has in the past been the victim.

An Electrical Windmill in Paris.—A little while ago M. Soifranc erected on the Montmartre Hill a windmill, which drives a dynamo at 110 volts, by which some accumulators are charged. It is sufficient to effect the lighting of a few lamps. The installation is certainly interesting, but we do not think it would be possible to utilise the wind in Paris for the production of an important amount of electrical energy.

The Double Carbon Arc Lamp.—In the action brought by the American Brush Company against the Western Electric Company for infringement of double carbon arc lamp, a verdict has been given in favour of the Western Electric Company. The Brush Company had formerly won sixteen actions on the same issue in different parts of the country.

Ten Thousand Dollars for Argon.—The Senate of the Smithsonian Institute, Washington, have voted the Hodgkins prize of $10,000 in equal proportions to Lord Rayleigh and Prof. Ramsay, in recognition of their discovery of argon.

Boston Statistics.—In Boston there are 220,000 incandescent lamps and 6,600 arc lamps, and the total amount of electrical energy generated aggregates 28,000 H.P.

Outing.—The whole of the staff from the works of the D. P. Battery Company, Limited, travelled on Saturday to Hastings, where they adjourned to the Royal Albion Hotel for dinner. The chairman, Mr. Jones, proposed a vote of thanks to the directors who had so liberally subscribed towards the outing, which was seconded by Mr. Martin, after which they separated to take advantage of the different enjoyments which awaited them, returning from Hastings at 7.35.

A New Theory of Electricity.—Dr. Gibbons, of Syracuse, says that electricity is cold instead of warm, and is capable of producing cold. He believes that in the near future electricity will be obtained in a liquid state, but we fear that before that happens Dr. Gibbons's thinking machine will "decline and fall" into a liquid state.

More Money Lending.—A financial paper says that a bank for financing electrical undertakings has, it is announced, been constituted at Zurich. The share capital is to be £1,200,000, of which 25 per cent. is to be paid up, and the directors are authorised to issue bonds to the amount of double the paid-up capital.

The 200 Miles an Hour Scheme to Let.—Dr. Wellington Adams's projected line between Chicago and St. Louis Electric Railroad, on which 200 miles an hour was to be attained, is no more. The company's offices are to let, and there are many creditors who would like a settlement.

Official Notices.—The *London Gazette* contains notices to the effect that the Universal Electric Lighting Company and the International Electric Storage Company, Limited, have each been voluntarily wound up.

Pure Carbon.—M. Moissan has found, judging by a note in "Digest" of the *Electrical World*, that the carbons used in his electric furnace are purified by the current, being freed from foreign materials.

A Fatal Shock.—An employé of the East River Electric Light Company, named Charles Grime, received a fatal shock of electricity at the company's works, New York City.

Big Amalgamation in the States.—The Baldwin Locomotive Works and the Westinghouse Electric Company have entered into a working alliance.

A Woman to be Electrocuted.—Maria Barberi, an Italian girl, who killed her lover with a razor, will be the first woman to be electrocuted.

Re Mr. Ronald A. Scott.—A first meeting of creditors was held at Temple Avenue on Wednesday before the Official Receiver.

Personal.—Dr. Nikola Tesla has had the Order of the Eagle conferred upon him by the Prince of Montenegro.

NEW COMPANIES REGISTERED.

Automatic Electric Sign Company, Limited (44,685).—This company was registered on July 23rd with a capital of £5,000 in £1 shares, to adopt agreements dated June 15th, 1895, between G. F. Kenyon of the one part and J. S. Critchley (for the company) of the other part, and to carry on the business of electricians, suppliers of electricity, advertising agents, and makers of signs and devices, ironfounders, mechanical engineers, machinery and toolmakers, &c. The subscribers (with one share each) are:—J. A. Jessop, 46, Ashgrove, Bradford, chemist; W. Craven, Reginald Terrace, Bradford, importer; G. F. Kenyon, 99, Aireville Road, Frizinghall, electrical engineer; T. Newboult, 8, Rand Street, Bradford, printer; E. Niven, Gas Works, Clayton, Bradford, electrical engineer; C. Wilson, 12, Alexander Crescent, Ilkley, secretary; H. Jackson, 3, Parkinson Chambers, Bradford, solicitor. The number of directors is not to be less than two nor more than five; the first are:—J. A. Jessop, W. Craven, and G. F. Kenyon (managing director.) Qualification 20 shares; remuneration as the company may decide. Registered office, 10, Tanfield Chambers, Bradford.

I.E.S. Accumulator Company, Limited (44,731.)—This company was registered on July 26th with a capital of £100,000 in £1 shares, to carry on business as electrical storage battery manufacturers and dealers, electrical engineers, electricians, mechanical engineers, electrical apparatus manufacturers, contractors for the supply of electricity. The subscribers (with one share each) are:—J. L. Higgs, Ashley Cottage, Walton-on-Thames, gentleman; E. Mann, The Cottage, Kingston-on-Thames, electrical engineer; P. Greville, Osmanthorpe, Laleham, electrician; C. E. Masterman, C.E., Northwood, Middlesex; J. B. Evans, Redbayes, Richmond, S.W., electrical engineer; J. Lloyd, 54, Florence Road, Stroud Green, gentleman; W. J. Griffiths, 40, Albert Road, N., gentleman. The number of directors is not to be less than three nor more than nine. The subscribers are to appoint the first. Remuneration £500 per annum, and a share in the profits divisible. Registered by J. L. Higgs, 43, Finsbury Square, E.C.

Phœbus Electric Battery Syndicate, Limited (44,774).—This company was registered on July 30th with a capital of £3,000, in £1 shares, to acquire, develop, work, turn to account, and deal with certain undescribed inventions relating to primary electric batteries, and to adopt a certain agreement. The subscribers (with one share each) are: A. Gianella, 213, Oxford Street, W., restaurant keeper; V. Guidotti, 11, Bridge Street, S.W., restauranteur; R. Maldifassi, 101, Shaftesbury Avenue, W., merchant; E. Pellas, Broad Street Avenue, E.C., merchant; C. N. Gauzentes, 82, Asylum Road, Peckham, chemist and electrician; M. Cizzio, 213, Oxford Street, W., clerk; E. Lovett, 18, Dempster Road, Wandsworth, clerk. Registered without articles of association. Registered office, Broad Street Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

J. E. H. Andrew & Co., Limited (22,223).—This company's annual return was filed on May 30th, when 1,465 shares were taken up out of a capital of £40,000 in £20 shares. 300 have been considered as paid, and £20 per share has been called on 1,200 shares, and the full amount paid. 35 shares on which the full sum had been paid have been forfeited.

Reuter's Telegram Company Limited (1,909 c).—This company's annual return was filed on June 19th. 11,839 shares have been taken up out of a capital of £100,000 in £8 shares, and the full amount has been called and paid.

Single Wire Multiple Telephone Signal Company, Limited (16,857).—This company's annual return was filed on June 21st, when 254 shares were taken up, and fully paid for, out of a capital of £5,000 in £10 shares.

CITY NOTES.

Crompton and Co., Limited.

The annual report of this company, with accounts to March 31st, is before us. In some respects, it is in appearance healthier than the previous one; the issue of debentures was fairly successful, and the amount so realised has facilitated the reduction of bankers' loans. The creditors, we notice, figure in the balance-sheet for £32,000, while trade debtors are represented by £64,000. It is to be hoped that the directors may see their way promptly to secure such prices that they may be able not only to keep their workshops full of work, but of work that will give a return to the shareholders.

Crompton & Company, Limited.

The seventh report of the directors, to be presented at the annual general meeting of the shareholders, to be held at the City Terminus Hotel, Cannon Street, in the City of London, on Friday, August 9th, 1895, at 3 o'clock p.m., states that the company's business has again increased, but, as will be seen from the accompanying statement of accounts made up to March 31st last, the net profits show a considerable falling off in consequence of the further reductions in prices forced upon the company. With regard to the current year, it is satisfactory to state that the company's order book is well filled, and the works are kept extremely busy—more so, probably, than at any previous time. The directors consider that a much healthier tone prevails in the business of electrical manufacturing, and they hope that there will now be a steady advance to better prices and better profits. The new debentures offered for subscription in January last were subscribed for to the amount of £82,850, which has provided additional working capital, and enabled the company to materially reduce the bankers' loans. With regard to the cooking and heating department of the company, the directors are pleased to report that they have, since March 31st, granted a license for the manufacture and sale of these appliances in France, the company receiving £1,000 for the privilege and a substantial royalty on all sales; negotiations are also in progress for granting licenses for other foreign countries. The net profits for the year amount to £6,953 10s. 11d., and after providing for debenture interest and other payments, there remains a net revenue balance of £2,343 15s. 9d., from which the directors

propose to set aside £1,000 for contingencies and doubtful debts, and to carry the balance, £1,343 15s. 9d., forward. They further propose to transfer the sum of £1,000 from the reserve fund in reduction of the preliminary expenses account. The seven years fixed by the purchase agreement of July 16th, 1888, during which the company secured the right to the services of Mr. R. E. Crompton and Mr. J. F. Albright as managing directors having expired, the board have made arrangements for a continuance of their services. The directors regret to state that in consequence of his having entered into other business engagements which necessitate his residing a long distance from London, Mr. H. H. J. W. Drummond has resigned his seat on the board of the company. In accordance with the articles of association, Mr. Bernard Gibson retires from the board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan & Co., also offer themselves for re-election.

The Edison and Swan United Electric Light Company, Limited.

Notice is given that an extraordinary general meeting of The Edison and Swan United Electric Light Company, Limited, will be held at the offices of the company, Ediswan Buildings, 36 and 37, Queen Street, Cheapside, in the City of London, on Friday, the 16th day of August, 1895, at one o'clock in the afternoon, when the subjoined resolution which was duly passed at the ordinary general meeting of the company held on the 29th day of July, 1895, will be submitted for confirmation as a special resolution under the companies' acts, viz.:—

Resolution.—Resolved that the articles of association of the company be altered by striking out Article 87 and substituting therefor the following Article:

87. The amount from time to time declared by the board as available for dividend, including the amount, if any, recommended by them to be withdrawn from reserve for equalisation of dividends shall be applied as follows:

(1) There shall be first set aside thereout a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited as paid on the "A" shares.

(2) Out of the sum so set aside there shall be paid a preferential cumulative dividend at the rate of 5 per cent. per annum on the amounts paid, or credited as paid, on the "A" shares without distinction.

(3) Subject thereto, there shall be paid out of the sum so set aside a further cumulative dividend at the rate of 2 per cent. per annum on the amount paid, or credited as paid, on the "A" shares, provided that, until all the "A" shares be fully paid, no "A" share, whether fully paid or not, shall for the purpose of this sub-section be deemed to have paid upon it more than the amount paid up or called up upon the "A" shares for the time being, having the least amount called up or paid thereon.

(4) The balance of the sum so directed to be set aside shall be carried to the reserve fund.

(5) The residue of the amount declared to be available for dividend, after setting aside the sum mentioned in sub-section 1, shall be applied in payment of dividends *pari passu* on the amounts paid up, or credited as paid, on the "A" and "B" shares, but so that, for the purposes of this sub-section, the amounts to be deemed paid up on the "A" shares shall be ascertained as in the case of sub-section 3.

Dated this Second day of August, 1895.

By Order of the Board,
H. Charles Gover, *Secretary.*

Electrical Power Storage Company, Limited.

The report of the directors, which was presented to the shareholders at the sixth ordinary general meeting, held yesterday week, stated that the net profit for the year is £3,419 16s. 9d., which, with a balance of £993 14s. 2d. from last year's accounts, amounts to £4,413 10s. 11d., out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,228 13s. 1d., leaving £184 17s. 10d. to be carried forward. Provision has been made for the effective maintenance of buildings, plant, tools, &c., at a cost of £2,373 7s. 3d. The reserve fund for diminution in value of assets has been increased by the sum of £2,684 12s. 11d. out of the profits of the year's working, and now amounts to £12,000. The directors are pleased to report that the company's batteries still maintain the leading position which they have for some years occupied. The company's staff has devoted considerable attention to reducing the cost of manufacture, and the directors have, in consequence, further reduced the selling prices.

Thomas Parker, Limited, Wolverhampton.

The first annual meeting of the shareholders of Thomas Parker, Limited, electrical engineers, was held last week at the works, Wednesfield Road, Wolverhampton. Alderman C. T. Mander presided, and there were present Messrs. T. Parker (managing director), W. Thomas, R. Willcock, R. Armistead, J. E. Underhill, H. P. Smith, M. Wilkie, and others.

The Chairman, in moving the adoption of the report, which has been published, said that the company did not commence work until January last, consequently the balance-sheet only represented six months' trading. The company had developed in a satisfactory manner, and during July it had increased to such an extent that additional hands had to be employed. He was pleased that the dispute with the Electric Construction Company was over, and, as a result of long negotiations, that company had paid them £2,000, and given them the right to use several patents which had not been included in the prospectus of Thomas Parker, Limited. Now that the points in dispute were settled, he hoped the public would take up the remainder of the shares, in order that the works might be extended. They had now over £24,000 worth of orders on the books, they were turning out an enormous quantity of work, and there was every prospect of a continuance of good business.

Mr. T. Parker seconded the motion. He said that the invoices for July were of the value of £5,000, and if that standard could be sustained—and he had no doubt it could—shareholders would find the business a profitable one. The turnover at the present time would earn a profit, and a little more capital expenditure would enable the directors to double the output. In fact, they could obtain any number of orders if they were in a position to execute them.

The resolution was adopted, and the chairman and Mr. W. Thomas were re-elected directors; and Mr. R. Armistead was appointed a director in the place of Mr. T. Graham, who had resigned office. Messrs. Allen, Edwards, and Smith were re-elected auditors, and a vote of thanks to the chairman terminated the proceedings.

The Liverpool Overhead Railway.

The report of the board of directors of the Liverpool Overhead Railway Company says:—In presenting the half-yearly statement of capital and revenue accounts to June 30th, 1895, the directors have to report that the gross revenue receipts amount to £28,143 3s. 1d., and the working expenses to £18,653 18s. 1d. The number of passengers carried since the opening of the railway has been as follows:—Half-year ending December 31st, 1893, 2,475,639; half-year ending June 30th, 1894, 2,861,437; half-year ending December 31st, 1894, 3,641,379; half-year ending June 30th, 1895, 3,460,060. These figures show a continued and satisfactory increase in the traffic. The contracts for the southern extension have been let, and the works will be commenced without delay. In order to meet the necessary expenditure, the directors have decided to offer to the shareholders at par, on application, the unissued portion of the ordinary capital. The amount available for dividend is £8,076 17s. 5d. Out of this balance the directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after August 17th—viz., 5 per cent, per annum on preference shares, £2,529 0s. 9d.; 2½ per cent. per annum on ordinary shares, £4,244 17s. 9d., leaving a balance of £1,302 18s. 11d. to be carried forward to next half-year.

Cuba Submarine Telegraph Company, Limited.

The ordinary general meeting of the Cuba Submarine Telegraph Company, Limited, was held on Wednesday, at 58, Old Broad Street, E.C., Mr. C. W. Parish presiding.

In moving the adoption of the report, which recommended a dividend of 8 per cent. per annum, the Chairman said the traffic receipts for the half-year amounted to £29,164, or an increase of £5,976, but this increase was quite abnormal, and resulted entirely from the unfortunate revolution now going on in Cuba. The expenditure was £6,118, or an increase of £1,105, but part of this sum was due to income-tax adjustment, leaving the actual working increase only £817. They had thought it advisable to add £1,500 to the reserve fund, against loss on deposits on banks. A sum of £3,540 remained as balance to carry forward, and they were also able to place £13,638 to the reserve fund. They were especially glad to be able to strengthen their reserve in that way, for he was bound to prepare the shareholders for the fact that a reduction in tariff appeared to be very imminent. It was most necessary that their financial position should be as strong as possible. In conclusion, he said their cables were working well, and were in excellent order.

Mr. G. Keith seconded the motion, which was adopted.

The House-to-House Electric Light Supply Company, Limited.—The directors have declared an interim dividend on the preference shares for the half-year ending June 30th at the rate of 7 per cent. per annum. The dividend is payable on 26th inst. The transfer books of the company will be closed from August 16th till 26th, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 4th, 1895, amounted to £804; week ending August 5th, 1894, £849; decrease, £45; total receipts for half-year, 1895, £4,294; corresponding period, 1894, £4,306; decrease, £82.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July, 1895, amounted to £1,889, against £1,400 in the corresponding period of last year.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending August 4th, 1895, amounted to £1,355; corresponding week last year, £1,000; increase £355.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,930.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, July 31st.	Closing Quotation August 7th.	Business done during week ended August 7th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	102½	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	46 — 48	47 — 49	48½	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88 — 89	88½— 89½	89	88½
2,993,560£	Do. do. Defd.	Stock	...	...	...	8½— 8⅝	8½— 9	8⅞	8 7/16
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13⅝— 14¼	13⅝— 14¼	14⅛	13⅝
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1½%	7/16 — ⅝	7/16 — ⅝	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾— 10¼	9¾— 10¼	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 xd	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9¼— 9⅝	9¼— 9⅝	9⅝	9 7/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	16¼— 17⅛	17⅛— 17⅝	17 7/16	16 15/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17¾— 18¼	17¾— 18¼	17⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	105 —108 xd	105½	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —129	126 —129	129	128
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅜— 17⅝	17⅜— 17⅝	17⅝	17⅝
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106 xd	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106 xd	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	127 —130	130	129½
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106 xd	102 —106	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	105 —108 xd	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115	112 —115%	113½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½% §	4½% §	4½%	10½— 10⅝	10½— 10⅝	10⅝	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17½	17⅛— 17⅝	17½	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21⅞— 22¼xd	21⅞— 22¼	22	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	107½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	49 — 52	49 — 52	51	50
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	6 %	6 %	6 %	107 —111	107 —111	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000	5	*nil*	4 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6 — 6⅞	6⅛— 6⅜	6⅛	6⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 17	16 — 18	17½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6¼	6 — 6¼	6¼	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —107 xd	105 —107	106¼	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	1/16 — 1/8	1/16 — 1/8	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½— 4½	3½— 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	126 —131	129	128
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½— 3	2½— 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97 xd	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½xd	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½— 11	10½— 11	10½	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4½— 4⅝	4½— 4⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	104 —106	101 —105 xd	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	104 —108	101 —105 xd	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	7/16%	¼%	⅜— 1	⅜— 1	⅜	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10¼	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4⅛%	4⅛%	5½— 5⅝	5½— 5⅝	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14 — 15	14½— 15	14⅝	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16 — 16½	15½— 16½	16 5/16	16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	133½	133
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8⅛— 9⅛	8⅛— 9⅛	...	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6 — 6½	6 — 6½	6 7/16	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅞— 7⅞	7⅞— 7⅞	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10⅞— 11¼	10⅞— 11¼	11¼	10 15/16
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	116 —119	116 —119	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 8⅝	8½— 9	8 5/16	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8¼xd	8 — 8¼	8¼	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½xd	9 — 9½	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅞— 8¼xd	7⅞— 8¼	8⅛	8 1/16
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	7⅞— 8¼xd	7⅞— 8¼	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, July 31st.	Closing Quotation, Aug. 7th.	Business done during week ended Aug. 7th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2 — 2⅛	2 — 2⅛	2⅛	2 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅛ — 2⅜	2⅛ — 2⅜	2 5/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000£	City and South London Railway	Stock	5/8%	5/8%	1¼%	41 — 43	41 — 43	41	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2 — 2½	1 — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2½	2 — 2⅜	2⅛	..
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	106¼	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	¾ — 1	¾ — 1	...	...
12,845	Do. — do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2½	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	7/16 — 1½	7/16 — 1½	1 1/16	7/16
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	5/16 — 1½	5/16 — 1½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
7,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10½ — 11½xd	10½ — 11½	11½	11¼
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 15½	15 — 15½	15	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	...	...
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	10½ — 10⅝	10 5/16 — 10⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15⅜ — 15⅝	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45 xd	43 — 45	44¾	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107 xd	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 4⅝	4⅜ — 4⅝	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & CO.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.
Chelsea Electricity Supply Ord., 6⅞—7¼.
Do. do. do. Pref., 7—7½.
Electric Construction Corporation, 6 % Debentures, 95—100.
House-to-House Company (£5 paid), 3⅞—4¼.
Do. do. 7 % Preference, of £5, 8—8½
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7⅜—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7½—8.
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5⅞—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

LOCATION OF GROUNDS IN ARMATURES, FIELDS, &c.*

THIS paper presents no novel scientific principles. The methods herein described are but simple adaptations of the principle of the Wheatstone bridge. They have been in use by the writer for several years, and he, having devised them for his own use, and found them very rapid, accurate and simple, is led to believe that they may be of considerable service to others. A slightly similar, but evidently less perfect, method was published by Mr. BRONSSON in the LONDON ELECTRICAL REVIEW. The insufficiency of Mr. Bronsson's method in cases where two grounds at some distance apart exist, is admitted. The methods herein described deal successfully with such cases.

If the work can be performed in a very quiet room, two or three cells of battery, a telephone receiver and connecting wires comprise the necessary apparatus. In some cases two "table binding posts" and a foot or two of No. 18 or No. 20 bright iron wire will be a convenient addition. Where noise will not permit the use of a telephone, a dead beat reflecting galvanometer, a milli-voltmeter, or some other form of delicate and rapid working visual indicator must be used instead. If an armature is to be tested without removing it from the machine, connection with the battery may be made through the brushes, first making certain that the short-circuiting switch is opened, if dealing with an arc machine. The points of connection with the battery need not be diametrically opposite, and may be made by the wires being firmly pressed against the commutator by an assistant, if more convenient.

Good electrical contact between metallic surfaces can better be secured by cleaning the same thoroughly with kerosene, which removes foreign matter, and is so fluid that it will in no way interfere with perfect contact, when moderate pressure is applied. Especially when making measurement of resistance of armature sections, it is even advisable to have the surface of the commutator quite wet with kerosene during the operation, as this avoids trouble from grease or dirt which might get on the surface from handling, subsequent to cleaning, and it also prevents the contact points becoming oxidised by any sparks which may occur at the moment of breaking contact. True, the oil is an insulator, but we use it in this case as a detergent simply.

Returning to the armature, connection being made between battery and commutator, first determine whether the armature circuit is complete throughout. If the circuit is complete, a click will be heard in the telephone when the two terminals of the same are brought in contact with any two contiguous bars of the commutator, or when contact is broken. If an open circuit exists on either side of the circuit, of course no sound will be heard in the telephone when used on that side, except when connection is made or broken by it between the bars lying on opposite sides of the break. (See fig. 1.)

Close any open circuit temporarily by bridging between the two bars with a drop of solder. Two or more breaks can evidently be located by suitably shifting the battery contacts, and searching as before. Open circuits will, of course, when an armature continues in work, soon cause burns between the bars that will indicate unmistakably their location. Having closed any open circuits, and the battery being connected to two points of the commutator, approximately opposite each other, one terminal of the telephone is connected to the armature shaft or frame of the machine, and the other terminal is drawn completely around over the surface of the commutator, while the telephone is held to the ear. If only one ground exists, two balancing points, or points giving the least noise in the telephone, will be found.

In an armature of ordinary construction, one of the points so found will be on the bar nearest the real ground, while the other balancing point bears what might be termed a "bridge relation" to the first, being at practically the same potential—the armature itself forming, in reality, a veritable Wheatstone bridge.

Now, shift the points of battery contact a few bars either way and the true ground, if but one exists, will be indicated in precisely the same position as before, while the other balancing point will shift every time the battery contacts are shifted. (See fig. 2.)

If two grounds exist, two balancing points will be found, as before, but both points will shift more or less when the battery contacts are shifted, provided the grounds lie on the opposite sides of the same battery contact. This case will be considered later.

In the case of one ground, having determined its location approximately, fix it as closely as may be by making and breaking contact with the telephone terminal on each of the more quiet bars separately, until by comparison, the two giving the faintest clicks are determined. If your hearing has served you correctly these two bars lie nearest the trouble, the fainter one being the nearer. Prove the non-existence of a second ground by placing one of the battery contacts on the first bar to the right of the apparently permanent balancing point just found, and then on the first bar to the left of the

* Read before the American Institute of Electrical Engineers, Niagara Falls, N.Y., June 25th, 1895, by Clarence E. Gifford.

said point, the other contact being nearly diametrically opposite. This balancing point should still remain unchanged if no other ground exists.

The next step is to connect the battery to these two bars just fixed upon as lying nearest the trouble. The armature still forms a "bridge," the portion included between the two contiguous bars to which the battery is now connected forming the one side, and the remainder of the armature the other side. (See fig. 3.)

One of the telephone terminals is now connected to the shaft as before, and the other terminal again drawn around the commutator. If the balancing point is found, say one-sixth to one-half, the long way around from one battery contact to the other (these contacts being on two contiguous bars), the trouble lies in the coil between those two bars, and the point of trouble divides the coil in the same ratio as the balancing point divides the remainder of the armature, the ground and the balancing point being respectively nearest the same battery contact. If the balancing point falls on the same bar as one of the battery contacts, the ground is located on that bar or on the lead between it and the armature, provided the balancing point is found to be upon the same bar when the battery contacts are both shifted one bar to the right or left of their original position. (See fig. 4.)

If the balancing point appears to be found within three or four bars from one of the contacts, the precaution should be taken to test its correctness by moving both battery contacts one bar toward the

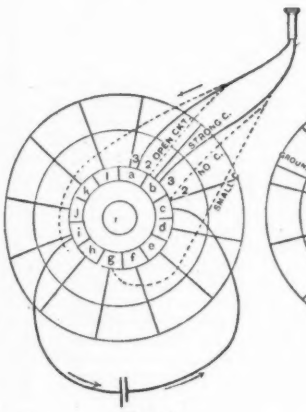


Fig. 1.

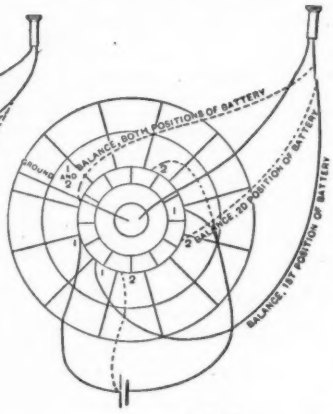


Fig. 2.

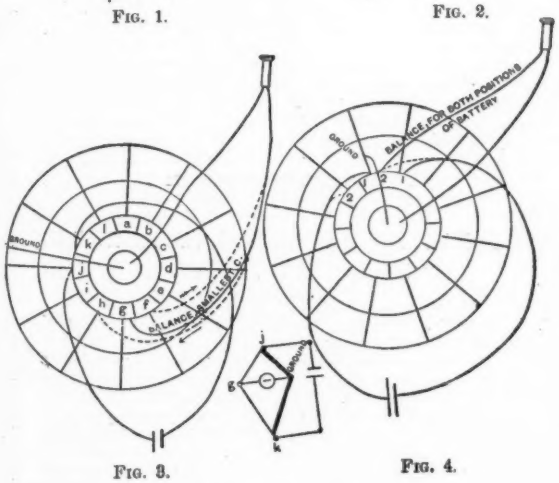


Fig. 3.

Fig. 4.

balancing point. If the trouble was between the battery contacts when in their previous position, this shifting of the contacts will now throw the balancing point clear around on to the contact, which was, in the previous position, farthest away from the balancing point. If, on the contrary, the balancing point remains unmoved by this shifting of the battery contacts, it shows that this balancing point is the point nearest the real ground, and that the car was deceived in its first supposed approximation, which, with due care, however, is not likely to occur.

If such error has been made, the new point, as indicated, together with first the bar on one side of it, and then on the other, must be tried as points of battery contact; or, much better, make a new start with the contacts nearly at opposite sides of the commutator, and proceed as before. A single 20,000-ohm ground on a 1-ohm armature should be located accurately in not over three minutes in a quiet room. Higher resistance grounds require more battery and more care. Armatures of very low resistance also offer greater difficulty.

Where two grounds are found to exist, as indicated by the change of location of both balancing points under the conditions before stated, when the battery contacts are shifted, the following mode of procedure will answer the purpose well, and is simple. Fix the battery contacts at any two points of the commutator nearly opposite each other, preferably at points to be determined by trial, that will cause the balancing points to fall nearly diametrically opposite to each other, and determine and mark the two balancing points, as then shown. Now place the battery contacts on the balancing points just found. If only one ground exists, the two balancing points and one battery contact will all be coincident in one point. If two grounds exist, both balancing points will be shifted from their former position. Open the armature circuit by unsoldering one of the ends of a coil connecting with the lead of the bar that is marked in the first part of this test as one of the balancing points. Place one of the battery contacts on the armature shaft and the other on the marked balancing point that is farthest from the point where the circuit has been opened. Next place one telephone terminal on the first bar to the right of the opened wire, and draw the other terminal from the same point toward the right over the surface of the commutator. The telephone will be absolutely silent until the moving terminal has just passed the ground nearest to it, and strikes the first bar beyond the same, when it will click. This ground lies in the coil between this first bar giving a click and the one passed just previously, or else in the said previous bar.

The other ground is obviously to be located in a similar manner, by placing one telephone terminal on the bar just to the left of the open wire, and from that point searching toward the left with the other terminal. Only in cases where one ground is of very low, and one of very high, resistance, will any difficulty be experienced in locating both accurately before either is removed.

The coils thus indicated may have their terminals unsoldered, when it can be readily ascertained with each whether the ground be in the coil or in the bar just preceding it.

If scientifically inclined, or if otherwise preferable, the circuit may be opened at a point somewhere midway between the two indicated coils instead of disconnecting those coils, and the exact location of each ground determined as follows:—Take a piece of "broom wire" about 18 inches long, new and clean, screw the ends firmly into two clean, brass table binding posts, and into the other holes of the same posts screw the battery terminals. Have an assistant press the corners of the bases of the binding posts into very firm contact with the two bars that lie at the ends of the indicated coil, observing the directions previously given for securing clean contact. Place one telephone terminal in contact with the shaft, and with the other find the balancing point on the wire. This point will indicate the relative position of the ground in the coil, or commutator bar, as the case may be. If more than two grounds were suspected, the two lying the farthest apart would be approximately located by the first part of the two ground process, and if these coils were not disconnected before proceeding farther, it would be well to make two openings in the circuit, close to and lying between these outer grounds, then locate definitely these two extreme grounds and proceed with the remaining section somewhat as with a complete armature, except that you would commence by connecting the battery to the terminals of this section, and would then bridge the telephone from the shaft to the different portions of the section, and would complete the process by applying the remainder of the two-ground test.

In dealing with a cross-connected Gramme ring, an obvious change would be made in the points of application of the battery, and as many points of apparent trouble would be indicated as there were series of cross-connections.

After location of these points, it would be necessary to use the auxiliary wire loop, as before described, between these points, to determine which is nearest the trouble. This fact being determined, it would in case of a single ground (indicated by the permanency of the balancing point) become necessary to remove the cross-connections from two bars before proceeding farther. The auxiliary wire loop would properly be used to complete the process.

The ordinary "closed coil" ring or drum armatures are types to which these methods are directly applicable.

The sections of open coil armatures would receive the same treatment as field coils.

Familiarity with any special forms of armature will doubtless suggest to the ingenious mind modifications of these methods suited to those forms, but it would be improper to attempt here to deal with specialties whose names are legion.

Where wet grounds exist, it will always be better, when practicable, to dry them out before making the final test, as certain sections may show faults which will not be permanent. Wet grounds will, of course, give a click in the telephone when bridged from the commutator to the shaft when no battery is attached, owing to galvanic action of the water on the copper winding and the iron core.

Whenever necessary to deal with wet grounds in testing, it is better to make at least four tests, reversing the battery after each test, and taking the mean of the four determinations.

Field coils, also any wires of uniform cross-section, the extremities of which are accessible and within a reasonable distance of each other, can, of course, be easily tested for grounds by soldering or firmly clamping a bare wire of suitable size between the extremities of the conductor to be tested, applying a battery to the junctions, and bridging with the telephone between the bare wire and the object upon which the conductor is grounded. This will give only the location of a single ground, or the "resultant" of two grounds. A "Thomson-Houston" rheostat should have the battery connected to the two extremities, and the point of apparent ground determined by bridging with a telephone between the frame and the several contact plates. Then apply the battery to the frame and point of apparent ground, connect one terminal of the telephone with each extremity successively, and search from it toward the centre with the other terminal, as in the case of searching for two grounds in an armature.

In determining the location of grounds that are of very low resistance, a good induction coil, similar to that used in the Blake transmitter, may be used with advantage in connection with the telephone receiver. The receiver is placed in circuit with the secondary of the coil, and the "bridging" is done with the primary. With high resistance grounds the best results are obtained by using the receiver only.

INTERVIEW WITH DR. CORNELIUS HERZ.

The Dying Savant and His Wonderful Inventions.

The following interview appeared in the *Pall Mall Gazette* on August 1st. We have something to say on the subject in our leader columns:—"The last act of Mr. Asquith before he was hustled from office was to remove the detective who, for over two years, has guarded the door behind which, in his house at Bournemouth, Dr. Herz lies dying. Beyond this cancelling of a sorry farce, for the greatest medical authorities in the land have declared that his case is hopeless, not an act, not a word of reparation has been offered by the last Government to the man whom they have so cruelly maltreated. Though not a shred of evidence has been produced to prove that he was ever concerned in the scandals attributed to him, though full inquiry has been begged for, and every facility for investigation offered, save that one which higher powers have denied, there still hangs over this man and over his family the disgrace of a warrant for arrest, issued without trial, at the bidding of a French political *canaille*, under circumstances which the *Pall Mall Gazette* has already made public.

"To the new Government, untrammelled by the shame of having to undo a wrong previously committed by them, we commend most earnestly this case of a dying political prisoner left in dungeon by their predecessors. It will be a stain upon English justice if Dr. Herz is allowed to die with a cloud of unmerited infamy overshadowing all his honours and past attainments. It will be an insult to English traditions if our law is allowed any longer to be made the tool of a factious set of politicians, anxious to save their hides by the persecution of a man they fear.

A Painful Scene.

A representative of the *Pall Mall Gazette* has just had what no pressman hitherto has been able to obtain, a personal interview with the great French *savant* at Dr. Herz's own personal request. Speaking with difficulty from the bed that he can never leave, worn out with anxiety, and with the pain of his merciless disease, Dr. Herz expounded in broken utterances the secret of a great invention, which he claims to have left behind him. What the details are cannot be revealed, for up to now they are not patented; "but you may believe on my word," said the dying man, noting a shade of scepticism in his listener, "that what I tell you is the minimum, not the maximum, of what my invention will accomplish.

"'You know that at present, owing to various causes of retardation, the best telegraphic instruments are incapable of transmitting more than 20 words a minute over long submarine cables. By my system it will be possible to transmit upwards of 100,000 words in the same short space of time. You will say that this sounds like a legend, like a wild flight of fancy, but it is not. It is fact already accomplished and capable of application to-morrow to all the instruments in existence. My experiments were carried out years ago, before I came to England and fell ill. I had at my disposal all the telegraphic lines of France during the night and the hours when they were not required by day. Since I have been here I have worked the system out completely, in its mathematical and all its other bearings. It only awaits the opinion of a well-known patent lawyer, and then the world may have the details.'

"'Is your system known to any of the great electricians—to Lord Kelvin, for instance?'—'It is not. I have not needed to consult others. Lord Kelvin knows me well, and would recognise me as an authority on such a subject. Many of our best electricians—Marcel Deprez, for example—have been trained in my laboratories in France. Bertrand's son was with me; so was a nephew of Edison's; and he, with 60 other electricians, was engaged upon the experiments of which I have just spoken.'

"'Have you calculated the effect of such an invention as you describe?'—'I have. It will revolutionise communication throughout the world. My system permits, in the first place, of so reducing the price of communication that it will be possible to cable a message of 50 words for the 2½d. which at present it costs to send a letter. In other words, the maritime postal service will be reduced to the condition of a parcels post, all verbal communication being instantaneous and practically void of cost.'

"'In the next place, consider the newspaper of the future. Papers like the *Times* and the *Pall Mall Gazette* spend very large sums upon private telegrams from different parts of the world in order to be first in the field with a certain quantity of news which I cannot help regarding as meagre. Think, now, of a paper with direct cable communication through to its own office, calling up New York, calling up Melbourne, at times suitable to their longitudes, and receiving direct information at the rate of speed I have indicated. Such a paper would control everything, and I have the power to make that paper, for in granting royalties I shall reserve this right as far as applies to news.

"'The ideal paper, to my mind, should have four editions, appearing once every six hours. In this way it could collect from places east and west of Greenwich an instantaneous supply of news at the proper time. Our news from one half the world, at the present rates, may be 12 hours behind time, because of the alternation of day and night. I should remedy that with my four editions.'

"'And you say that this system, with its extraordinary possibilities, is ready for application?'—'It is ready to-day. It can be applied to the siphon recorder system, even to the Morse instrument, which, you know, is in many cases unworkable. This is not all. It will render submarine telephony possible, and it will admit of multiplex telephony, a thing scarcely dreamt of, much less attempted. But the crowning achievement, as I said at the beginning—and I repeat that this is no Jules Verne fancy, but an accomplished fact—the crowning achievement is that for 20 words per minute in modern submarine telegraphy, my invention will substitute upwards of 100,000.'

"'And will you allow no indication of the principle of your system to be published?'—'I cannot; for, as I have said, it is not patented. When I am gone, however, you will see this thing come to pass, and you will say, "It is even as Dr. Herz told me," No. I have described my invention to no one, and it has never before formed the subject of conversation with any but one or two of my most intimate friends. In telling you what it will accomplish, I am asking you first to assume as an hypothesis that it is true. For it is I who tell you so, and my name is far from unknown in connection with electrical science. For instance, it is my telephone that was adopted by the French Government, and is now in use between Paris and Belgium. No man of science but Pasteur, and no Jew, has ever before been admitted, as I was, to the highest orders of the Legion d'Honneur; and as a man of science, I was chosen to represent the United States at the great International Congress of Electricians in 1881. And now—for no crime that I have committed . . . .'

"Some Personal Views.

"In deference to the evident anxiety of Mdme. Herz, the interview would here have ended; but 'Doctor,' as his watchers call him, signified that he had still something to say. This was to acknowledge the efforts which the *Pall Mall* had already made on his behalf, and to add a few words of personal explanation on his case. He and his family had pleaded, he said, for an amendment to the Extradition Act, which would enable his case to be heard *in absentia*; and though the draft of this amendment, shown him by Sir Edward Reed, had been in Mr. Asquith's own handwriting, yet Mr. Asquith had declined to support it in the House. It had seemed as if not only justice, but even inquiry, was denied in England to a man who had been made a political scapegoat. He had no crime whatever on his conscience but the folly of having tried to serve France in high matters of State, which had brought him the enmity of a certain class of politicians, and more especially, of course, of those who hated the Jews. The supposed attempt to extort money from Baron de Reinach, which was the sole charge left against him, was based upon an extract from an official telegram which had nothing whatever to do with money, but which (as the complete text shows) bore reference to certain delicate negotiations which Dr. Herz was conducting in Italy on behalf of the French Government. 'And for this I am condemned to die in dishonour, because there is a flaw in an English Act!'

"Stretching forth a wan hand, Dr. Herz said, 'Do you notice anything there?' A quick pulse was beating between the finger and the thumb. 'That pulse is beating in my feet, and over most of my body. It is the final symptom in cardiac disease. For months past this has been creeping upon me, and now my last hope is gone, even of moving into a room in the front of the house from which I could see the sea. No one who has not been through it can appreciate the torture of this race between death and the restoration of my good name. What the *Pall Mall Gazette* can do, let it do, in the cause of simple justice. But remember one thing—it is my right that I want, not mercy or humanitarian sentiment.

"As the writer left the room, not a little tried himself by the strain of two hours' conversation under such painful circumstances, a lady's voice murmured in his ear, 'Let it be mercy, or humanity, or what you will; but, for Heaven's sake, let it be release from this most terrible position.'"

THE GAS LIGHT COMPANY AND THE ELECTRIC LIGHT.

Col. Makins, the Governor, in addressing the shareholders of the Gas Light and Coke Company at the half-yearly meeting last Friday, said that some persons had spoken to him about the extension of the incandescent gas light as likely to be disadvantageous to the company, but in a district like theirs, which was more or less laid hold of by the electric light, the substitution of the incandescent system for the electric light and the consequent increase in the use of gas, could not fail to widen the basis of their operations. It was therefore really a good friend to the gas company, and he hoped that its use would be largely extended. He hoped also that the London County Council would make some experiments in the use of the incandescent gas light before involving the public in a very large outlay by lighting the embankment with electricity, for he believed it would entail an annual outlay three times as much as that necessary for gas. Then again if they introduced the incandescent gas they would get a very brilliant light and it would cost them no more than it did at present.

Dr. Wilde said that in the vestry of which he was a member, he had endeavoured to induce them to adopt the incandescent gas light, but he was not successful as the influence of the electric light interest was so great. He thought that the Gas Light and Coke Company, unless they bestirred themselves very much in the matter of the Embankment and the County Council, would not be successful in inducing that body to give the incandescent light a good trial. The electric interest was very strong and very clever. In connection with the Embankment question he might mention that very heavy vehicles passed along there, and it might be sufficient to fracture the mantles of the incandescent gas lamps. The great weakness of the incandescent light was the shield, and he should like to know whether any of their engineers had had the matter under consideration sufficiently to be able to state whether they could substitute something for the present mantles, or whether something could be done to reduce the vibration to a minimum.

Mr. Fraser stated that he had followed the question of lighting very closely at Brighton and Hove, and the Hove Commissioners had incurred enormous expense in the matter. He was pleased to say

that he had been the means of inducing the authorities to use a certain number of incandescent lamps, and now the whole of the remainder of the lighting was to be of that kind, which he thought put the electric light into the shade. Decidedly the reports brought home by the sailors and fishermen were very favourable, for they said that the light could be easily distinguished as being a better light than the electric. Therefore, he thought the incandescent light was one of their very best friends as it was checking the extension of the electric light to a very considerable extent.

The Chairman quite agreed that an experiment ought to be tried in lighting the Embankment with the incandescent gas, but he questioned whether it could be fairly tried by the London County Council. As to the vibration being a great drawback, he might say that there had been invented a spring, which held the mantle in suspense, in such a manner that vibration did not injure it—in fact, it had been proved that in the highest gales, when the lamps were shaking, the mantles sustained no damage at all, so that there was very little danger in that respect. He was glad to hear what Mr. Fraser had said about the progress of the light in Brighton, for he looked upon the system as a friend and not as an enemy.

ON THE USE OF THE QUADRANT ELECTROMETER AS A DIFFERENTIAL INSTRUMENT.*

By RICCARDO ARNO.

Let A B, and C be three points of a circuit in which an electromotive force is acting, and let A and B be the extremities of a resistance, r, inserted in the same circuit. If, by means of the variation of such resistance, we cause successively to vary the two differences of potential, $V_A - V_B$ and $V_B - V_C$, existing respectively between the points A B, and B C, it is always possible by means of a single experiment with an ordinary quadrant electrometer (which does not require to be standardised), and with a method of reduction to zero to determine when corresponding to a given value of the resistance, A B, these two differences of potential are equal.

If we place the two points, A and C, respectively in communication with the two couples, Q_1, Q_1' and Q_2 Q_2', opposite quadrants of the electrometer and the point, B, in communication with the needle, h, of the said electrometer, and if we denote by W, the momentum of the deviating couple we may write:

$$W = k\,[(V_A - V_B)^2 - (V_C - V_B)^2],$$

where k is a constant. Hence it is seen that $W = 0$, and that there is no deflection of the movable part of the apparatus when

$$V_A - V_B = \pm\,(V_B - V_C).$$

The necessary condition is sufficient when the two differences of potential are equal and that on making the connections in question the needle of the electrometer remains in its position of equilibrium.

It is easy to demonstrate, and this is the more important, that the method now explained is applicable also whenever it is required to show the equality of two differences of effective alternating potentials $V_A - V_B$, and $V_B - V_C$, existing respectively between the points A B, and B C, in which an alternating electromotive force is acting.

In fact on calling w the momentum of the deflecting couple at a given instant at the end of a certain time, t, and v_a, v_b, v_c, respectively, the values of the potentials in A, B, C, at the same instant, we may write:

$$w = k\,[(v_a - v_b)^2 - (v_c - v_b)^2].$$

This being established on multiplying both members of this equation by $d\,t$ and integrating between the limits, 0 and T, where T is the period of the alternating electric force we have:

$$\int_0^T w\,d\,t = k\left[\int_0^T (v_a - v_b)^2\,d\,t - \int_0^T (v_c - v_b)^2\,d\,t\right],$$

or, again, by dividing both the members by T:—

$$\frac{1}{T}\int_0^T w\,d\,t = k\left[\frac{}{T}\int^T (v_c - v_b)^2\,d\,t - \frac{1}{T}\int_0^T (v_c - v_b)^2\,d\,t\right].$$

On designating, then, by W the mean value of the momentum of the deviating couple, we have, finally,

$$W = k\,[(V_A - V_B)^2 - (V_C - V_B)^2],$$

from which equation we deduce that $W = 0$ when

$$V_A - V_B = \pm\,(V_B - V_C).$$

Then, also, in this case the necessary condition is sufficient, because the two differences of the effective alternating potentials of which we are treating may be equal, and there is no deviation of the movable part of the apparatus.

The foregoing demonstration shows the applicability of the method in case of differences of the alternating potentials, and places in evidence a notable fact, that is, that the method far from being applicable only in the case in which the electromotive force in question is sinusoidal, is in fact general, and is hence strictly applicable whatever may be the law according to which the same force varies as a function of time.

The method, which may be suitably called the *method of the differential electrometer*, may receive various useful applications, among which are, *e.g.*, that which refers to the measurement of electrostatic capacity and induction, in which case it is sufficient to have at disposal, beside the quadrant electrometer employed in the manner above described, an alternating difference of potential between two points, A and C, and a self-inductionless rheostat, A B.

For experimenting, after having arranged the rheostat between the two points, A and C, and in series with the condenser, and the spiral of which it is sought to determine respectively the capacity and the induction, we put the two points, A and C, in connection with each couple of the opposite points of the electrometer, and the point, B, in communication with the needle of the said electrometer. Things being thus arranged, in general the movable part of the apparatus will deviate by a certain angle, but the resistance may be always made to vary tentatively until the needle returns to its position of equilibrium. From the value, r, of the resistance which is found inserted between A and B when this condition is satisfied, the capacity, c, is found of the condenser, or the induction, L, of the spiral which is being experimented on. Hence if we call I the effective intensity of the alternating current, we may write—

$$V_A - V_B = r\,I.$$

Further, if we begin to consider the case of the measurement of the electrostatic capacity of a condenser we have then, treating the alternating electromotive force which acts in the circuit as sinusoidal:

$$V_B - V_C = \frac{1}{2\,\pi\,n\,c}\,I,$$

where π is the ratio of the circumference to the diameter and n the frequency of the alternation. And when the needle of the electrometer is at zero,

$$V_A - V_B = V_B - V_C,$$

whence is directly deduced:—

$$r = \frac{1}{2\,\pi\,n\,c}$$

$$c = \frac{1}{2\,\pi\,n\,r}.$$

If r is expressed in ohms, the result is expressed in farads. If instead we wish c expressed in microfarads, as it will be more convenient in practice, the formula will be written:

$$c = \frac{10^6}{2\,\pi\,n\,r}.$$

In case of the measurement of the induction of a spiral, we have instead, still treating the alternating electromotive force which acts in the circuit as sinusoidal, and calling r' the real resistance of the spiral in question,

$$V_B - V_C = \sqrt{r'^2 + 4\,\pi^2\,n^2\,L^2}\,I$$

Whence

$$\sqrt{r'^2 + 4\,\pi^2\,n^2\,L^2} = r,$$

whence we deduce,

$$L = \frac{1}{2\,\pi\,n}\sqrt{r^2 - r'^2}.$$

If r and r' are expressed in ohms, L is expressed in henries.

Practical experiments were made with two condensers of mica, the one of one-third microfarad, by Elliott, of London, and the other of one-half microfarad, by Carpentier, of Paris.

The experiments were performed with a difference of effective alternating potential between the two points, A and C, equal to 100 volts. The frequency of the alternating current was 42. In these conditions the needle of the electrometer remained in its position of equilibrium in correspondence to a value of r, equal to 11·180 ohms for a condenser of one-third microfarad, and equal to 7·820 ohms for a condenser of one-half microfarad.

There was then obtained for the first case, $c = 0{\cdot}339$ microfarad, and for the second case, $c = 0{\cdot}485$ microfarad.

And since both in the first and in the second experiment there was observed a sensible displacement of the luminous image on the scale when the resistance, r, was made to vary by 10 ohms, it resulted that the approximations with which these results were obtained are of 0·0004 microfarad (0·12 per cent.) in the first experiment, and 0·0006 (0·12 per cent.) in the second experiment.

* Abstract from the *Rendiconti* of the Royal Lyncean Academy, Vol. iii., 2nd half year, Series V., part 5.

ALTERNATE CURRENT MOTORS.

By W. G. RHODES, M.Sc.

(*Continued from page* 24.)

We have hitherto supposed that the E.M.F. of the generator and the counter E.M.F. of the motor are due simply to the exciting current which passes round their respective field coils, or that the excitations of the fields are fixed by the

field currents. Now this is not quite true, since the magnetisation of the fields depends upon all the magnetising forces in the neighbourhood, and consequently upon the combined effects of the currents in both the field and armature coils.

The effect of the armature current in magnetising or demagnetising the field is usually called *armature reaction*.

We devote considerable space to the consideration of armature reaction, because it is treated in a very loose way, and often altogether erroneously, by writers on the subject.

The whole question of armature reaction turns upon the phase relationships of the current and the E.M.Fs. of generator and motor. Our investigation will include both generator and motor, because both questions are of importance when the whole plant is taken into consideration.

Let fig. 9 be a diagrammatic representation of an alternate current machine running as a generator, and the direction of rotation being clockwise. If the armature is wound as in the figure, the E.M.F. will be a maximum when an armature coil is midway between two consecutive field coils, since the number of lines of force due to the field enclosed by the armature coil is then a minimum (zero), and the rate of cutting lines of force is a maximum. If the armature current is in phase with the E.M.F., it is evident that the average armature reaction is zero, because the current then attains its maximum value when the coil is midway between two consecutive field coils, and (the rotation of the armature being clockwise) whatever effect an armature pole, A, (see fig.) has on a field pole, S, as it recedes from it, there will be an equal but opposite effect on the consecutive pole, N, on its approach. The same would be true if the difference of phase between E.M.F. and current were 180°, as might be the case if the machine were running as a motor. Thus, in the case of a generator, the average armature reaction is zero, if the E.M.F. and armature current are in phase, and in the case of a motor if the counter E.M.F. and current are in exact opposition.

Now suppose that the current and E.M.F. are not in phase, but that the former leads over the latter by some angle (less than 180°). Consider the same poles in fig. 9. The current in the coil, A, will now attain its maximum value before it reaches the position midway between S and N, so that the effect of the current in A on the pole, S, will be greater in

Fig. 9.

magnitude than its (opposite) effect on N. But the lines of force due to the field current pass through the armature in the direction, N to S, as shown by the dotted lines in the figure, and the lines of force due to the armature current are in the direction from armature to field, from A to S; thus the effect of the current in A, as A passes from S to N, is to strengthen the pole, S, and weaken the pole, N, but to a less extent; therefore the average effect of the leading current is to strengthen the field. By similar reasoning we may show that a lagging current weakens the field when the machine is running as a generator.

If the machine were running as a motor, the armature current at any instant would flow in opposition to the counter E.M.F., so a similar course of reasoning shows that the tendency of the current in A would be to weaken the pole S and strengthen the pole N; and that the average effect of a leading current is to weaken the field of a motor. Similarly, the average effect of a lagging armature current is to strengthen the field of a motor.

We have now proved that the field of a *generator* is *strengthened* when the current *leads* before its E.M.F., and *weakened* when the current *lags*; and that the field of a *motor* is *weakened* when the current *leads* before its counter E.M.F. and *strengthened* when the current *lags*.

We proceed to investigate the phase relationships. Fig. 10 is fig. 8 slightly altered. E_1 T e O and E_1^1 T e^1 O are the parallelograms of E.M.Fs. for the two values of the counter

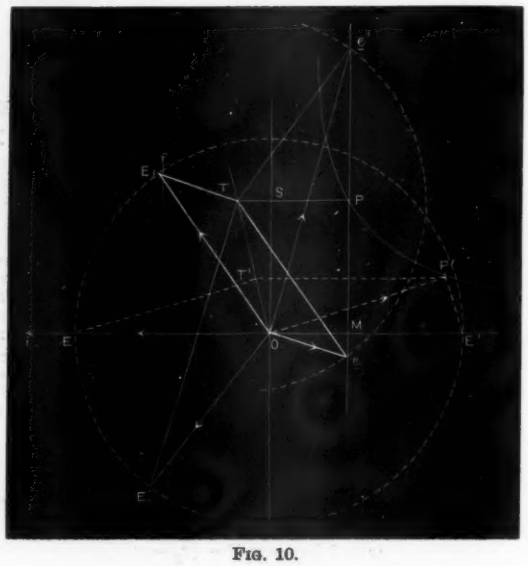


Fig. 10.

E.M.F., having given the E.M.F. of the generator and the current; and E T^1 P^1 O is the parallelogram of E.M.Fs. corresponding to minimum current.

The direction of rotation, we must remember, is *clockwise*.

Let us suppose that the output of the motor and the E.M.F. of the generator are kept constant, while the excitation of the motor, and consequently its counter E.M.F., is varied, starting at small values and increasing to over-excitation.

When the counter E.M.F. is small, as at O, e (fig. 10), the current, i, leads over the counter E.M.F., e, by the angle e O i, and lags behind the generator E.M.F., E, by the angle i O E_1. On increasing the excitation of the motor, the angle of lead of i over e will increase, and the angle of lag of i behind E will diminish, when e differs in phase from i by 180°, i still lags behind E. Continuing to increase e, the angle of lag of i behind E diminishes till the excitation corresponding to minimum current is reached, when i and E are in phase, and i now *lags* behind e. If we still further increase e, i will *lead* before E, and *lag* behind e.

We may note that this gives a theoretical explanation of the experimental fact, observed by Prof. S. P. Thompson* and others, that an over-excited synchronous motor behaves like a condenser, and causes the current to lead before the E.M.F. of the generator.

Referring, now, to what is said above on armature reaction, we see that when the excitation of the motor is small, the fields of both generator and motor are weakened by armature reaction. When e is in exact opposition to i, the field of the motor is unaffected, while that of the generator is weakened. When working at minimum current the field of generator is unaffected, and that of the motor is strengthened. If e is greater than the value corresponding to minimum current, the fields of both generator and motor are strengthened by armature reaction.

We now proceed to investigate a formula by means of which we may calculate in ampère-turns the change in the

* B.A. report, 1894, "Some uses of Alternate Currents," by S. P. Thompson.

field excitation due to the armature current. We shall assume that the current curve is of the sine form. To fix our ideas, suppose that the machine is running as a generator, and that the current leads over the E.M.F. by an angle, ϕ. The current will then attain its maximum value when an armature coil occupies a position A, say, as in fig. 9. The time taken by an armature coil to rotate through the distance between two consecutive field poles is (see first article of this series) equal to half the periodic time of the current.

If we suppose the armature to rotate as before, in the clockwise direction, the current in the coil, A (fig. 9), will be zero at a distance, ϕ from S, and again at a distance, ϕ from N. We must here note that an angle, 2π, in fig. 10, is in fig. 9 represented by twice the distance between two consecutive poles, N and S, of the field. A little consideration will show that the resultant strengthening of the field is due to the mean value of the current through an angle, ϕ, on each side of its maximum value, and not to the current as measured by a dynamometer or other alternate current ammeter.

Let $i_o \sin pt$ be the current in the armature, so that i_o is its maximum value. If i is the virtual current, we know that

$$i\sqrt{2} = i_o.$$

Also the mean current, I, through an angle, ϕ, on each side of the maximum value is given by

$$\begin{aligned} \text{I} &= \frac{p}{2\phi}\int_{\frac{\pi-2\phi}{2p}}^{\frac{\pi+2\phi}{2p}} i_o \sin pt\, dt \\ &= \frac{i_o}{2\phi}\left\{\cos\left(\frac{\pi}{2}-\phi\right) - \cos\left(\frac{\pi}{2}+\phi\right)\right\} \\ &= \frac{i_o}{\phi}\sin\phi \\ &= \sqrt{2}\cdot i\,\frac{\sin\phi}{\phi} \end{aligned}$$

If now n is the number of conductors in one section of the armature, the excitation in ampère turns due to the armature current is given by the product of the mean current through the angle, 2ϕ, the angle 2ϕ and n, or

$$\begin{aligned} &= \sqrt{2}\cdot i\,\frac{\sin\phi}{\phi}\,2\phi\,.\,n \\ &= 2\sqrt{2}\cdot i\,n\sin\phi \\ &= 2{\cdot}828\,i\,n\sin\phi \text{ approximately.} \end{aligned}$$

To find the total excitation of the field, we must add this expression to, or subtract it from, the ampère turns on the field, according as the current leads or lags in a generator, and lags or leads in a motor. If the machine is running as a motor, ϕ in the formula is the difference between 180° and the lead or lag.

We must note that the change in the E.M.F. of the machine due to the armature reaction does not bear the same proportion to the E.M.F., due solely to the field excitation, as the ampère turns as calculated by the above formula bear to the field ampère turns; the reason of this is seen if we bear in mind the fact that the air gaps in the magnetic circuits are constantly varying.

Example.—We will apply our calculations to obtain a numerical estimate of the effect of armature reaction in a practical case.

Suppose we are given that

$$\begin{aligned} e &= 1{,}000 \text{ volts.} \\ \text{R} &= 10 \text{ ohms.} \\ \text{S} &= 20 \text{ ohms.} \\ i &= 25 \text{ ampères.} \\ n &= 60. \end{aligned}$$

and that the plant is working under the conditions of minimum current in the line. Then the phase relationships are represented in fig. 11. The generator E.M.F. is in phase with the current, that is, $\psi = 0$.

Resolving E.M.Fs. along and at right angles to the line of current, we get

$$\left.\begin{aligned} \text{E} &= \text{R}i + e\cos\phi \\ \text{and}\qquad e\sin\phi &= \text{S}\,i \end{aligned}\right\}$$

whence $\sin\phi = \frac{1}{2}$; or $\phi = 30°$

and $\text{E} = 916$ volts.

We get, therefore, for the effect in ampère turns of armature reaction on the excitation of the field of the motor the number

$$2{\cdot}828 \times 25 \times 60 \times \tfrac{1}{2} \text{ approximately,}$$

or 2,121,

and since the current lags behind the counter E.M.F., e, of the motor, the field excitation will be increased by armature

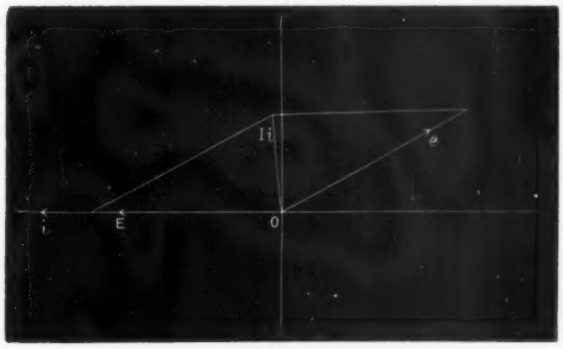


FIG. 11.

reaction. If we wish to know the percentage increase in the excitation, we must know the number of ampère turns due to the field current. For such a machine as we are considering, the field ampère turns would probably be of the order 7,000 to 8,000, so that the percentage increase in the exciting ampère turns due to armature reaction would be about 20 per cent. If, as is usual, the value of e is somewhat greater than the value corresponding to minimum current in the line, the percentage increase in the excitation will be higher, and the field of the generator will also be strengthened, but to a less extent.

On account of the variations of the resistance of the magnetic paths, we cannot calculate the change in the E.M.Fs. of the machines unless we know the mean resistance of the magnetic circuits. The numbers given above show, however, that in making our calculations we cannot neglect armature reaction without introducing serious errors and considerable discrepancies between theoretical conclusions and observed facts.*

(To be continued.)

NEW PATENTS—1895.

13,934. "Improvements in the method of generating electricity for lighting or motive power." F. Gray. Dated July 22nd.

13,957. "Improvements in trolley systems of electric propulsion and apparatus therefor." A. G. New. Dated July 22nd.

13,958. "Improvements in trolley systems of electric propulsion and in apparatus therefor." A. G. New. Dated July 22nd.

13,961. "Improved connector for the rails of electric tramways and railways." H. H. Lake. (Communicated by the Compagnie de l'Industrie Electrique, Switzerland.) Dated July 22nd.

13,978. "Improvements in the method of and means for stopping electrically propelled cars." A. K. Bonta. Dated July 23rd. (*Complete.*)

14,014. "An improved electric switch." H. S. Jones, of the firm of W. P. Thompson & Co. (Communicated by H. Stuebner, H. T. Paiste, and W. G. Miller, United States.) Dated July 23rd.

14,019. "Improvements in or connected with apparatus for electrically lighting miners' safety lamps." W. Ackroyd and W. Best. Dated July 23rd.

14,023. "Improvements in writing telegraphs." P. A. Newton. (Communicated by T. Ewing, jun., United States.) Dated July 23rd. (*Complete.*)

14,049. "Improvements in electric arc lamps." D. Higham. Dated July 23rd. (*Complete.*)

14,051. "A method and apparatus for electrically transmitting writings or drawings." B. Pell. Dated July 23rd.

* [*Erratum.*—In fig. 7 of our last article, the line drawn from R to E should be drawn from O to E, to complete the parallelogram, O e T E.]

14,066. "Improvements in winding armatures for dynamos and electromotors, specially applicable to alternators and alternate current motors." The Hon. C. A. Parsons. Dated July 23rd.

14,095. "Improvements in electric battery cells and in the method of applying same." B. Doyle. Dated July 24th.

14,113. "Improvements in the electrolysis of alkaline chlorides." A. R. Davis. Dated July 24th.

14,114. "Electrical apparatus having movements determined by variations of the electrical resistance of bismuth in a magnetic field." J. Hessberger. Dated July 24th. (*Complete.*)

14,134. "Improvements in rapid telegraphic transmission on cable lines." C. Langdon-Davies. Dated July 24th.

14,142. "Improvements in apparatus for the recovery of gold by electrolysis from the sea." M. W. W. Mackie. Dated July 25th.

14,147. "Improvements in electric and other railways and in vehicles therefor." R. C. Sayer. Dated July 25th.

14,158. "Improvements in and relating to primary batteries." W. Rowbotham. Dated July 25th.

14,160. "Improvements in conduits for electric wiring." E. W. Lancaster. Dated July 25th.

14,203. "Improvements in electric switches or parts for making and breaking circuits in electric machinery." W. A'C. G. Birkin. Dated July 25th.

14,233. "Process of making acid proof vessels and electric insulators." E. Whitworth and B. Doyle. Dated July 26th.

14,246. "Improvements in alternating current electric motors." G. E. Dorman. Dated July 26th.

14,257. "Improvements in or connected with the arrangement of conductors for electrically-operated agricultural implements." H. Schimpff. Dated July 26th.

14,275. "Improvements in and connected with junction boxes for electric mains." H. Edmunds. Dated July 26th.

14,313. "Improvements in the manufacture of carbon plates, cylinders, and cells for electrical purposes." R. H. Courtenay. Dated July 27th.

14,337. "An improved method of and means for working electric fire-alarms." J. A. Bakker. Dated July 27th. (*Complete.*)

14,342. "An improved electrolysing apparatus." J. Kolb and A. D. A. Lambert. Dated July 27th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

1,542. "Improvements in or relating to fac-simile telegraphy." H. W. C. Cox and R. J. Crowther. Dated January 24th. Relates more particularly with the application of the system to transmit writing, drawings, shorthand, signatures, maps, plans, cipher and other written or printed matter. 10 claims.

6,458. "Improvements in dynamo electric machines." S. Z. de Ferranti. Dated March 31st. The inventor makes dynamo electric machines with iron armatures pierced with holes close to their surface nearest the field magnets, and winds these with the electric conductor in which the currents generated by the magnetic field are produced. In order to satisfactorily insulate these conductors, he inserts insulating tubes in the holes in the iron. 16 claims.

7,950. "Improvements in apparatus for electrolytical purposes." H. Guthrie. Dated April 21st. Consists in constructing the diaphragms proper of some loose granular substance, that may be either soluble or insoluble, such as salt or sand respectively, as may best suit the particular operation in hand, and which is held in position by screens of insoluble material. 5 claims.

8,328. "Improvements in electric condensers." G. Threlfall. (A communication from abroad by Prof. R. Threlfall, of Sydney.) Dated April 26th. A condenser according to the invention is made with a dielectric, such as paper of a pure and uniform description impregnated with oil at a suitable temperature, such as 140° Centigrade. 3 claims.

8,412. "Improved method of, and means for, controlling or converting electric currents." A. Frazer. Dated April 27th. Relates to a novel method of, and means for, controlling electric currents, in such a manner as to allow of their being passed through either high, or low, induction transformers, and to render said currents adaptable for any of the purposes to which electricity is applicable, irrespective of the nature of the current primarily generated. Thus, say, for converting continuous into alternating currents, or *vice versa*, or both conversions synchronally combined. 5 claims.

8,730. "Improvements in, and connected with, supports for electrical batteries used on vehicles and the like." T. Froggatt. Dated May 2nd. Consists in the mounting of the battery upon elastic or flexible supports carried by the vehicle or other device upon which the batteries are situated, so arranged that when the battery is put in place the connections are automatically made. 2 claims.

8,731. "Improvements in electric batteries." T. Froggatt. Dated May 2nd. Consists in covering over an orifice for the escape of gas with a flexible nipple having a small slit or hole in it, made, for example, by piercing it with a sharp pointed instrument, and not by removing any material therefrom. 2 claims.

8,825. "Improved means for conducting electricity through table-cloths, carpets, and the like, to electric lamps and other electrical devices." The Electrical Installation Co., Ltd., and E. L. O'Brien. Dated May 3rd. In connection with the conducting wires below the cloth or carpet the inventors employ a frame of wood, ebonite, or other non-conducting material, divided by non-conducting material. In the respective halves or divisions of this non-conducting frame they place metallic gauze or a plate of metal, and they connect the two conducting wires respectively with the gauze or plates in the two divisions. The wires in the lamp terminate in needle points, which, when the lamp is placed upon the table, pierce the cloth and make contact with the metallic gauze or metal plates below, and thereby complete electrical connection between the lamp and the source of supply. 4 claims.

9,368. "Improvements in electric fuses." F. Brain. Dated May 11th. Claim:—In electric fuses of the types described, after bringing the bared terminals of the two wires up through the wad or disc at two defined points, turning the bared ends of the wires back and over the outside of the wad so as to clip it as and for the purposes set forth.

9,605. "Improvements in electric motors." W. M. Mordey. Dated May 16th. Consists in providing both the armature and field with a number of magnetic poles arranged in alternate order, and arranging by means of a commutator and one or more brushes, to short-circuit the coils of the armature or of the field during a portion of each phase. 1 claim.

9,930. "Improvements in signalling on railways, and means therefor." The Automatic Electric Railway Signal Company, Ltd., E. Blakey, and J. P. O'Donnell. Dated May 22nd. Consists in the employment, in addition to the ordinary electrical arrangement of the single-needle block, or other system, electrical circuits provided with relays and having a series of contact devices adapted to be actuated by the train, the arrangement being such that a train, on entering a section, will automatically place the signal controlling that section at "danger," and the signalman at the commencement of such section will be prevented from clearing the signal until the train has passed out of the section, and he has received the "line clear" signal from the signalman in advance. 5 claims.

10,101. "An improved gripping tool for electric light and other fittings." G. Binswanger and W. E. Gibson. Dated May 24th. Has for its object the production of a tool, by the use of which electric lamp sockets and other like fittings may be removed and replaced within a very limited space, such for instance, as a bell or flower-shaped shade, without risk of damage to the latter. 2 claims.

10,140. "Improvements in regulators for electric currents." W. Habtnell. Dated May 25th. Has reference to a self-acting, electrical, governing apparatus, by which resistances, or their equivalents, are thrown in and out of circuit. 5 claims.

10,353. "Improvements in pendant fittings for electric lamps and the like." J. Morris, jun. Dated May 28th. Has for its object to provide a simple and efficient device whereby an article can be suspended and readily regulated to any desired distance from its point of support, and consists essentially in suspending the article by a flexible connection and in providing between the article and the support a device on which any desired portion of the connection can be wound at leisure. 4 claims.

10,487. "Improvements in electrical measuring and signalling instruments." H. W. Sullivan. Dated May 30th. Consists of two magnets, preferably semi-circular in shape, and two coil systems. 7 claims.

10,917. "Improvements in electric safety fuses or cut-outs." S. Z. de Ferranti. Dated June 5th. The fuse is formed of a thin copper wire supported in its centre on a ridge of porcelain or other refractory non-conductor, and having each of its ends attached to a spring which spring is in turn attached to the terminals of the apparatus. The springs are drawn up to the level of the fuse wire, and being surrounded by a vessel are immersed in thick oil. The fuse wire itself is in air and is very short. The current passes from one terminal through the spring attached to it, through the fuse wire down by the other spring, and out by the terminal. When the current becomes too strong the fuse wire melts and the springs on each side of the insulating ridge spring back into the oil and become entirely immersed, so putting out the arc which follows on the breaking of a high-tension fuse. 9 claims.

10,952. "Improvements in electrodes." C. Hoepfner. Dated June 5th. The essential feature of invention in the electrodes consists in so constructing the same that any desired active or conductive surface can be obtained with as small pieces of carbon as possible. 11 claims.

11,225. "Improvements in and relating to arc electric lamps." H. Bevis and H. Hirst. Dated June 9th. The essential feature of the invention is to enclose the arc within a block or cube of lime, or like substance, so that the light rays are emitted from a suitable orifice, and the substance or material being heated by the radiation of the arc, increases the illuminating power thereof, and also neutralises the colour. 2 claims.

12,140. "Improvements in electric igniters." A. A. C. Swinton. Dated June 23rd. Consists in the use of a small transformer or induction coil of any suitable description, having two coils, one of comparatively many turns of relatively fine wire, which is connected to the electric supply, the other of comparatively few turns of relatively thick wire in circuit with the strip or wire to be heated. 3 claims.